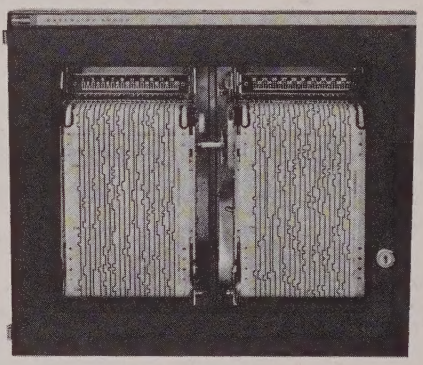
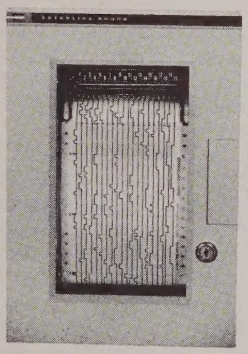
INSTRUCTION MANUAL

FOR MODEL A620X AND MODEL A620T EVENT RECORDERS

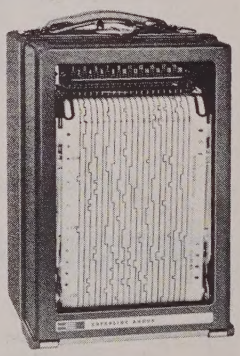
Serial No. _____



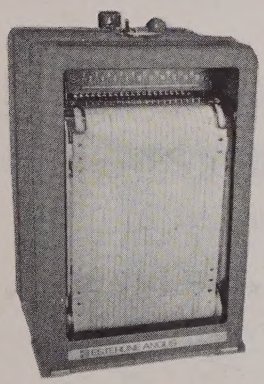
TWIN
(FLUSH CASE ILLUSTRATED)



FLUSH MOUNTED



PORTABLE



FRONT MOUNTED

MP MASTER
MA30340

ESTERLINE ANGUS
AN ESTERLINE COMPANY

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NOTE: FOR A COMPLETE TECHNICAL DESCRIPTION OF YOUR SPECIFIC INSTRUMENT, SEE THE DATA SHEET WHICH IS SUPPLIED IN A SEPARATE ENVELOPE AT THE BACK OF THIS MANUAL. SPECIAL DRAWINGS AND SUPPLEMENTARY INSTRUCTIONS THAT MAY BE REQUIRED WILL BE LISTED ON THE DATA SHEET AND WILL BE FOUND IN THE APPENDIX OF THIS MANUAL.

WARRANTY—The products sold hereunder are warranted as free from defects of materials and workmanship and in conformance with specifications. There are no other oral, statutory, or implied warranties. Seller's obligation hereunder shall be and is limited to servicing or replacing said product f.o.b. at its plant in Indianapolis, Indiana or at such other point as Seller may designate, or refunding the purchase price of any such product which proves to be defective in material or workmanship or which fails to conform to specifications therefor, provided that (1) written notice of such defect or failure is received by Seller from Purchaser within one year after the date of shipment of such products by Seller, and (2) such defects, in the opinion of Seller, shall not have arisen from improper use. The absence of such written notice of defect, or failure, or lack of conformance to specifications within the specified time shall constitute a waiver of any claim. Seller may, after receipt of notice, require purchaser to send said products, transportation prepaid, to Seller for its examination and inspection.

PART A

GENERAL INSTRUCTIONS

SECTION 1 - INTRODUCTION

1.1 SCOPE OF MANUAL

a. This manual covers technical instructions for the installation, operation, and maintainance of your Esterline Angus instrument. The manual is divided into the following separate parts: PART A - contains general information about the instrument and its installation; PART B - contains complete instructions for the chart drive system of the instrument (graphic recorders only); PART C - contains instructions and specifications on the various measuring systems available for the instrument; and PART D - the Appendix, covers optional accessories and attachments plus technical data as required for special instrument modifications.

NOTE: If supplemental instructions in the Appendix conflict with statements in the basic manual, the supplemental data shall be considered authoritative.

b. Do not attempt to operate the instrument until all instructions have been studied. Failure to follow recommended procedures may result in unsatisfactory operation or permanent damage to vital parts of the equipment.

1.2 SUPPLIES AND PARTS

a. For graphic recording instruments, always keep enough Esterline Angus charts on hand to operate each unit for at least one month. If the instrument uses ink, Esterline Angus inks are available in four standard colors--red, green, purple, or black. Red ink will be supplied unless otherwise specified. By purchasing in large quantities, worthwhile savings can be made on these supplies.

b. When ordering replacement or spare parts, always give the instrument serial number as well as the individual part numbers. Refer to the Data Sheet and to the various assembly drawings in this manual for correct part numbers.

SECTION 2 - INSTALLATION

2.1 UNPACKING

a. Since all Esterline Angus instruments are carefully inspected and packed before shipment, carriers are responsible for any damage in transit. Should a packing case appear damaged, make a notation to that effect on the express receipt or freight bill. If the shipment is damaged, notify the carrier and Esterline Angus at once.

b. A packing slip listing all enclosed items is included with each shipment. Check off the items as they are unpacked; if anything is missing, go through the packing material carefully before throwing it away. New instruments are shipped complete with recording supplies and accessories as required for the particular systems ordered. Each instrument having a flush-styled case will also include a set of keys for the door lock.

2.2 INSTALLING CASE

a. The instrument should be mounted upright and approximately level in a clean, well-lighted location for all permanent installations. The internal systems should not be subjected to vibration or extremes of temperature and humidity. If excessive dust, steam, moisture, smoke, or corrosive fumes are present, a protective cabinet should be constructed for the unit. The cabinet must be properly vented, however, to maintain a flow of air through the case when heat producing components are supplied.

b. Instruments should not be positioned close to bus bars or cables carrying large currents due to possible adverse effects of strong magnetic fields; this is especially true for instruments having electrical DC measuring systems.

c. When installing the instrument on a panel, always refer to mounting dimensions. Series resistances, and other accessories, if used, will either be attached to the instrument case or supplied as a separate unit. All separate boxes will be marked with the instrument's serial number; and all resistance boxes must be mounted in a vertical position. Never place a resistance multiplier box in a closed area or obstruct the flow of air through it.

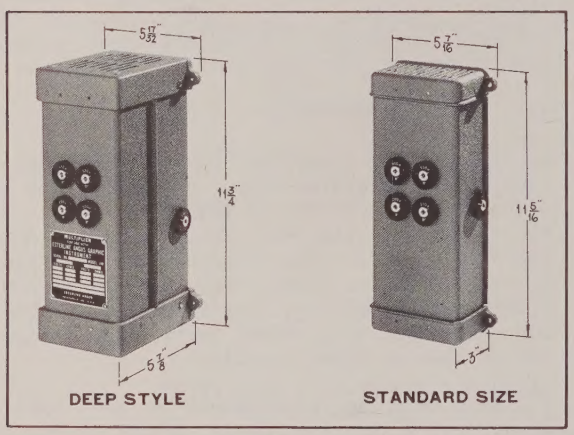


Figure A1. Multiplier Boxes For Attachments.

d. The cases of portable, front switchboard, and wall-type instruments have latches that can be sealed with standard meter seals or locked with a small padlock. On all flush cases, the door is fitted with a flush latch and built-in lock. Two keys are furnished with each instrument and these keys fit any flush-case lock.

NOTE: For case installation of instruments having non-electrical measuring systems, refer also to PART C of this manual.

2.2.1 Portable

A portable model features a carrying handle and removable front cover. The bottom of the portable case has four holes drilled and tapped for No. 10-24 screws to fasten the instrument to any flat surface. Power, if required, is supplied by a line cord at the rear of the case. Input terminals are tapered and threaded to receive either tapered plugs (usually furnished on leads) or binding posts.

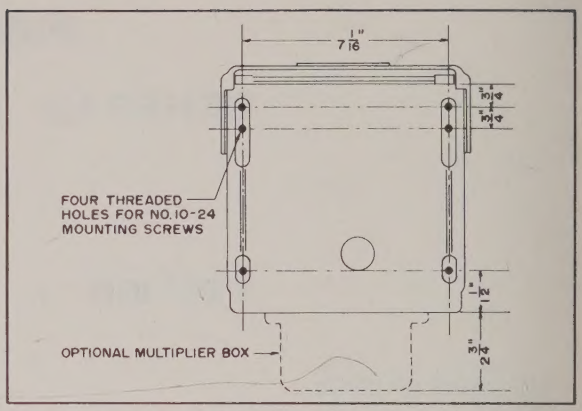


Figure A2. Portable Case Base Mounting Holes.

2.2.2 Flush

a. Each flush case instrument has a hinged door with large viewing window. The flush case body and mounting flange are die cast as a single unit. It can be mounted on panels of almost any thickness. A set of screws are supplied for standard panel mounting. If panel material is thin and of a large area, additional supports may be necessary (consult factory).

b. Twin cases fit standard relay racks with no cutout required. However, a shim may be necessary at the case front for door clearance. See the diagrams in this section for exact cutout and drilling dimensions. All electrical connections are made to terminals at the back of the instrument.

2.2.3 Front Switchboard

Front switchboard instruments have a removable front cover and three rear mounting studs. Mounting hardware is also supplied. Units with electrical measuring systems are calibrated for either insulated or metal mounting surfaces (as specified prior to shipment). Consult mounting dimensional diagrams in this section for either single or twin installations. Electrical connections are made to studs (independent of mounting studs) at the back of the instrument.

2.2.4 Wall

a. Cases designed for hanging on the wall feature a removable front cover and also a mounting and wiring compartment attached to the back of the case. Three mounting lugs are provided on the case, but due to the many installation possibilities, mounting hardware is not supplied.

b. Electrical connections are made to terminals inside the wiring compartment, and removable terminal covers are provided on the

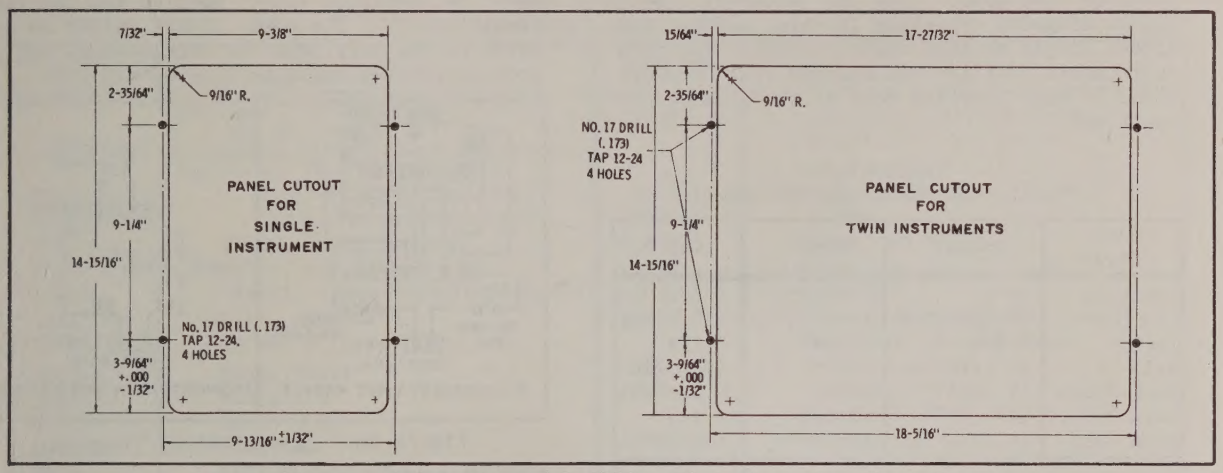


Figure A3. Panel Cutouts and Drilling Dimensions for Flush Cases.

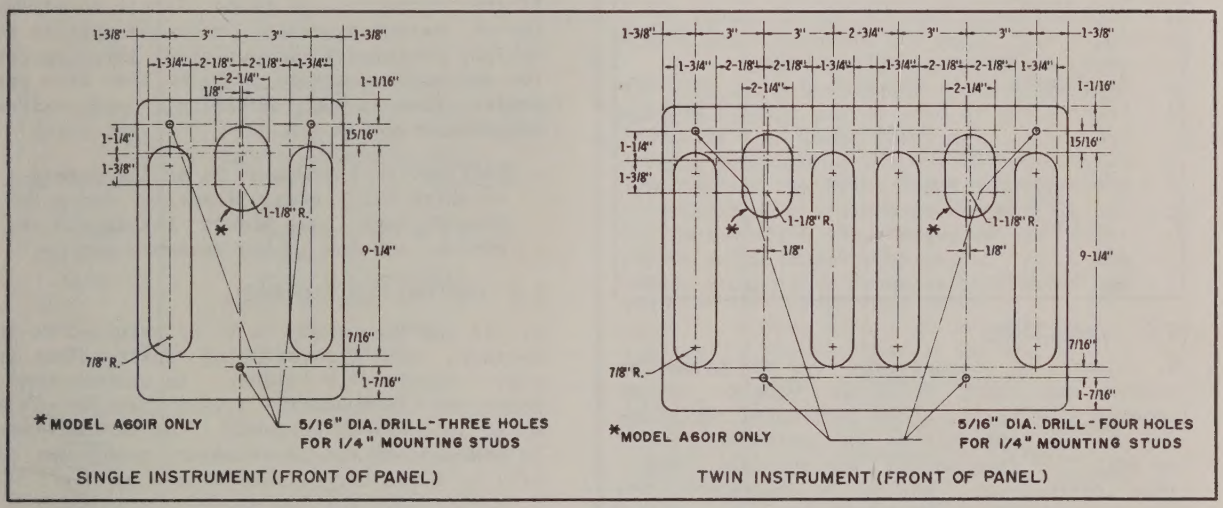


Figure A4. Panel Cutout Templates for Front Switchboard Cases.

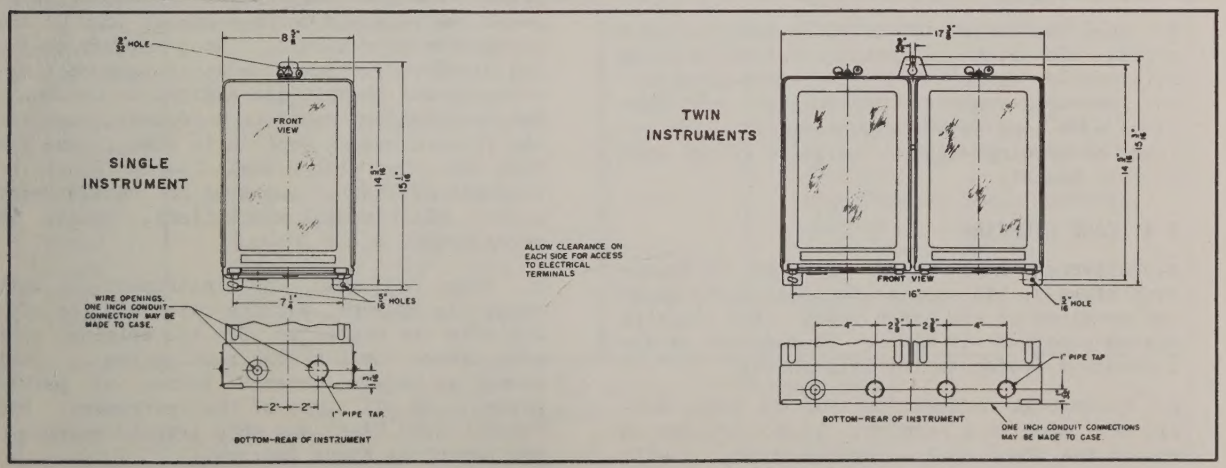

SINGLE INSTRUMENT
FRONT VIEW
WIRE OPENINGS. ONE INCH CONDUIT CONNECTION MAY BE MADE TO CASE.
1" PIPE TAP
BOTTOM-REAR OF INSTRUMENT
ALLOW CLEARANCE ON EACH SIDE FOR ACCESS TO ELECTRICAL TERMINALS
TWIN INSTRUMENTS
FRONT VIEW
1" PIPE TAP
BOTTOM-REAR OF INSTRUMENT
ONE INCH CONDUIT CONNECTIONS MAY BE MADE TO CASE.

Figure A5. Mounting Dimensions for Wall Style Cases.

sides of the case. See the mounting dimensional diagrams supplied in this section for either single or twin installations. For twin instruments, it is recommended that connections be made from the rear of the case before mounting.

TABLE A1
OVERALL INSTRUMENT DIMENSIONS

Case Style	Height	Width	Depth
Portable	14"a	8 9/16"h	9 5/16"bf
Flush	15 23/32" c	10 9/16"ci	8 3/4"bdg
Front	14" a	8 3/4" j	9 1/4"
Wall	15 1/16" e	8 5/8" j	10 15/16"
Twin Flush	15 23/32" c	19"ci	8 3/4"bdg
Twin Front	14"	17 1/2" j	9 1/4"
Twin Wall	15 3/16" e	17 3/8" j	10 5/8"

Table Legend:

a - From bottom of case to top of latch.
b - Add 3 1/2" (max) for standard, and 6 1/2" (max) for deep multiplier boxes.
c - applies to front flange and door.
d - Front panel to back of instrument. Maximum projection from front panel is 1 11/32".
e - Extreme bottom and top of mounting lugs.
f - Add 3/16" for Model A601R w/o multiplier.
g - Add 3/4" for Model A601R w/o multiplier.
h - Add 4" for external chart drive motor.
i - Add 2 7/8" for external chart drive motor.
j - Add 3 7/8" for external chart drive motor.

2.3 CONNECTIONS

a. Electrical connections for the measuring system and chart drive are made to either tapered plug holes, screw terminals, or binding posts at the rear of the instrument. Refer to PART C of this manual for specific connection instructions, and to the instrument Data Sheet supplied at the back of this manual for input ratings.

b. When the instrument is to be operated in a system with other equipment, Esterline Angus will provide information for recommended connections upon request. If special modifications have been ordered, supplemental instructions or drawings may be included in the back of this manual.

2.4 CASE LIGHTING

a. Internal lighting is provided in flush-type cases to illuminate the indicating scale and portions of the strip chart. The lighting system supplied is either fluorescent or incandescent (refer to the Data Sheet).

b. Electrical connections for the light module are made to a terminal block provided on top of the flush case. Twin instruments will have two separate light modules and two terminal blocks. The power ON-OFF switch is located on the left-front of each module, and is accessible with the case door open.

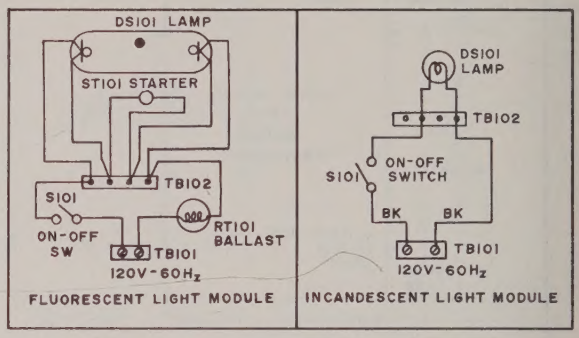


Figure A6. Case Lighting Diagrams.

2.5 STORAGE

If the instrument is to be placed in storage for an extended period, pack the unit in the upright position in its original shipping carton and store where it will be free from corrosive fumes, high humidity, and extreme temperatures.

CAUTION: If instrument is an ink recorder which will remain inactive for more than 30 days, all liquid ink should be removed and the inking system cleaned.

2.6 PACKING FOR SHIPMENT

a. If the instrument is to be returned to the factory, send for shipping instructions and state reason for return. In correspondence about the instrument, always identify it by model and serial numbers. The serial number is stamped on the instrument nameplate and will be found on the Data Sheet.

b. Before shipment, REMOVE ALL LIQUID INK (if used) from the instrument; considerable expense can be saved on many repair jobs if this precaution is followed. Wrap removable writing elements in paper or cotton and pack in a separate box. HANDLE ALL ASSEMBLIES CAREFULLY. Remove exterior mounting hardward. See that the front cover or door is in place, and protect the glass with a small board. If the instrument is to be repaired or recalibrated, return all leads, multipliers, shunts and accessories.

c. Wrap and seal the instrument in heavy paper to prevent packing material from sifting into the mechanism. Use the original shipping carton or a strong packing box - large enough to permit several inches of packing material on all sides of the instrument. Mark "HANDLE WITH CARE" and ship prepaid express to the Esterline Angus factory.

TABLE A2

CASE ASSEMBLY

REPLACEMENT PARTS LIST

PART NO.	DESCRIPTION
	PORTABLE, SWITCHBOARD AND WALL CASES
	Removable Front Cover Assy.
8761-13	Gray Wrinkle (Complete)
8761-10	Black Enamel (Complete)
8793	Glass, Front Window
8794	Glass, Top Window
01397	Gasket, Glass (Specify Length)
4892	Clip, Glass (6)
ST-43	Screw, Clip Mounting (6)
8808-A	Hinge Shaft
8799	Nameplate
8806	Latch Stud
X-2110	Stud Nut
8820	Bottom Slot Cover (Rubber)
0373	Rubber Gasket, Cover
	Cover (Less Parts)
8751-13	Gray Wrinkle
8751-10	Black Enamel
	Case Assembly (Complete)
8760A-13	Gray Wrinkle (Less Cover)
8760A-10	Black Enamel (Less Cover)
	Handle (Portable Only)
19790-G	Gray
19790	Black
NX-90806	Mounting Screw (4)
SP-1208	Washer (4)
X-2108	Mounting Nut (4)
8802	Latch Handle
8805	Mounting Screw
8804	Washer (Top)
NX-2111	Nut
X-107	Washer (Bottom)
8752	Hinge Hook (2)
17422	Heat Switch (Mod. A620T)
17450	Decal, Heat Switch
8935G	Power Cord (Portable Only)
	SINGLE AND TWIN FLUSH CASES
	Door Assy. (Single Case)
19872-12*	Charcoal (Complete)
19872-15*	Gray (Complete)
	Door Assy. (Twin Case)
19882-12*	Charcoal (Complete)
19882-15*	Gray (Complete
19830	Door Lock Assy.
19844	Front Glass (Single Case)
19848	Front Glass (Twin)
19826	Gasket, Glass (Specify Length)
19828	Clip, Glass (Right Side)
19836	Clip,Glass (Left Side)
19814	Clip, Top & Bottom Glass (Single)(2)
19838	Clip, Top & Bottom Glass (Twin)(2)
	Latch Assy.
19802-11	Charcoal
19802-14	Gray
19834	Clamp, Latch Pin (2)
19818	Hinge Pin, Latch Plate (Twin)(2)
19824	Gasket, Door (Specify Length)
	Nameplate (Single Case)
19840-D	Charcoal
19840-C	Gray
	Nameplate (Twin Case)
19840-B	Charcoal
19840-A	Gray
	Case Assembly (Single)**
19874-50	Charcoal (Less Door)
19874-14	Gray (Less Door)
	Case Assembly (Twin)**
19884-50	Charcoal (Less Door)
19884-14	Gray (Less Door)
19832	Lock Plate
19810	Retainer, Striker Plate
19809	Striker Plate Assy., Latch
19812	Flush Hinge (Single)(2)
19875	Flush Hinge (Twin)(2)
19816	Hinge Pin (2)
19877	Pin Bracket, Hinge (Twin)(2)
19888	Roll Pin (Twin)(2)
12895	Plug Button (As Req'd)
19715-1	Plastic Closure (As Req'd)
	Light Module (Complete)
19707-1	Fluorescent (2/Twin)
19707-2	Fluorescent (Mod. A620T)
19709-1	Incandescent (2/Twin)
19709-2	Incandescent (Mod. A620T)
19760	Terminal Block (TB101)
19733	Switch, ON-OFF (S101)
ND40073-2	Terminal Board (TB102)
19712	Fluorescent Lamp (DS101)
19723	Fluorescent Lamp Socket (2)
19740	Fluorescent Starter (ST101)
19727	Fluorescent Starter Socket
19725	Fluorescent Ballast (RT101)
081	Incandescent Lamp, 120V/15W (DS101)
082	Incandescent Lamp, 250V/10W (DS101)
19735	Incandescent Socket
17422	Heat Switch (Mod. A620T)(S102)
19717	Switch Decal (Mod. A620T)

* Add Suffix "-1" for chart feed-through door.

** Specify light module.

PART B

CHART DRIVE SYSTEM

SECTION 1 — DESCRIPTION

1.1 INTRODUCTION

a. This part of the manual includes a general description, operating procedures, and maintenance instructions on the various chart drives available for your Esterline Angus recorder. Refer to the Data Sheet which is supplied at the back of this manual for the specific chart drive supplied with the instrument.

b. The chart drive (Fig. B1) is an accurate and reliable paper-propelling mechanism which has been expressly designed for long trouble-free operation. Drive components are mounted on rigid box-like aluminum frames to maintain alignment of all parts, and thereby reducing gear-train friction and providing smooth chart feeds. On most electric drives, external connections are provided for remote operation.

c. Standard chart speed ranges are available from 3/16 inches-per-hour to 3 inches-per-second for "inch" drives, and from 12-1/2 millimeters-per-hour to 100 millimeters-per-second for "metric" drives. An almost limitless variety of chart speeds may be obtained through the use of change gears, auxiliary gearing, and special sychronous motors. The various standard chart speeds available are listed in Table B1 along with the chart drive number needed to obtain each speed range.

d. Series "A" chart drives are currently available in five basic design categories: Synchronous Motor, Hand-Wound Spring, Motor-Wound Spring, Selsyn Motor, and Phantom. With the exception of the phantom design, the internal power source for a drive is therefore either an electrical motor, stored energy in a mechanical spring, or a combination of these systems. Phantom drives require an external driving source, however they come equipped with either an internal electrical or mechanical system to reroll the chart paper.

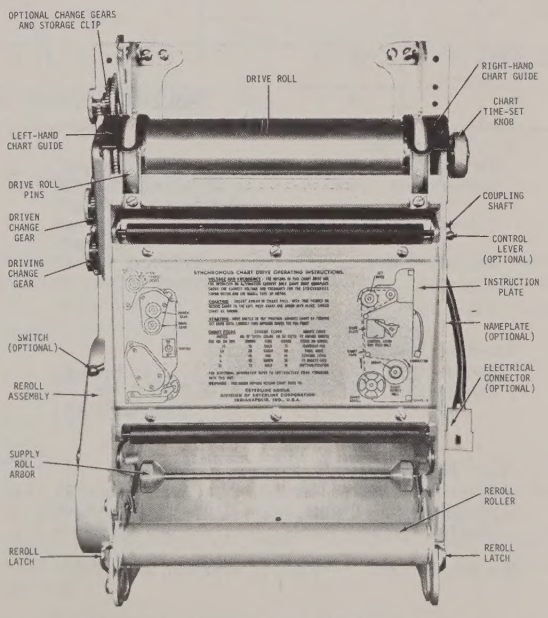


Figure B1. Typical Series "A" Chart Drive.

TABLE B1 STANDARD CHART SPEEDS

CHART DRIVE TYPE NO.	GENERAL DESCRIPTION	INCH DRIVES			METRIC DRIVES		
		inches per hour	inches per minute	inches per second	mm per hour	mm per minute	mm per second
1	Hand-wound Spring, Hour Speeds Only	¾, 1½, 3, 6, 12	.....	.....	12.5, 25, 50, 100, 200	.....	.....
2	Hand-wound Spring, Hour and Minute Speeds	¾, 1½, 3, 6, 12	¾, 1½, 3, 6, 12	.....	12.5, 25, 50, 100, 200	12.5, 25, 50, 100, 200	.....
2A	Hand-wound Spring, Hour and Minute Speeds with Electric Shift	¾, 1½, 3, 6, 12	¾, 1½, 3, 6, 12	.....	12.5, 25, 50, 100, 200	12.5, 25, 50, 100, 200	.....
4	Synchronous Motor, Hour and Minute Speeds	¾, 1½, 3, 6, 12	¾, 1½, 3, 6, 12	.....	12.5, 25, 50, 100, 200	12.5, 25, 50, 100, 200	.....
4A	Synchronous Motor, Hour and Minute Speeds with Electric Shift	¾, 1½, 3, 6, 12	¾, 1½, 3, 6, 12	.....	12.5, 25, 50, 100, 200	12.5, 25, 50, 100, 200	.....
6X	Phantom, Spring Reroll, without Clutches	No power unit. One revolution of coupling shaft moves chart 3/4, 1 1/2, 3, 6 or 12 inches with corresponding gears in place. Coupling shaft supplied.			No power unit. One revolution of coupling shaft moves chart 12.5, 25, 50, 100 or 200 mm with corresponding coupling gears in place. Coupling shaft supplied.		
6C	Phantom, Spring Reroll, with Drag Clutch						
6CC	Phantom, Spring Reroll, with Drag and Back-up Clutches						
6EX	Phantom, Electric Reroll, without Clutches						
6EC	Phantom, Electric Reroll, with Drag Clutch						
6ECC	Phantom, Electric Reroll, with Drag and Back-up Clutches						
51	Motor-wound Spring, Hour Speeds Only	¾, 1½, 3, 6, 12	.....	.....	12.5, 25, 50, 100, 200	.....	.....
52	Motor-wound Spring, Hour and Minute Speeds	¾, 1½, 3, 6, 12	¾, 1½, 3, 6, 12	.....	12.5, 25, 50, 100, 200	12.5, 25, 50, 100, 200	.....
52A	Motor-wound Spring, Hour and Minute Speeds with Electric Shift	¾, 1½, 3, 6, 12	¾, 1½, 3, 6, 12	.....	12.5, 25, 50, 100, 200	12.5, 25, 50, 100, 200	.....
55	Synchronous Motor, Second Speed Only	.....	.....	¾, 1½, 3	.....	.....	12.5, 25, 50
56	Synchronous Motor, Hour and Minute Speeds, USED ONLY WITH 55 DRIVE	¾, 1½, 3, 6, 12	¾, 1½, 3, 6, 12	.....	12.5, 25, 50, 100, 200	12.5, 25, 50, 100, 200	.....
56A	Synchronous Motor, Hour and Minute Speeds with Electric Shift, USED ONLY WITH 55 DRIVE	¾, 1½, 3, 6, 12	¾, 1½, 3, 6, 12	.....	12.5, 25, 50, 100, 200	12.5, 25, 50, 100, 200	.....
60	Selsyn	¼, ½ or 1 inch per revolution of Sylsyn with ¾, 1½ or 3 inch gears in place.			6.25, 12.5, 25 mm per revolution of Selsyn with 24 and 64 tooth, 39 and 52 tooth and 54 and 36 tooth gears in place.		
60C	Selsyn with Back-up Clutch						

Note: Additional speeds are available. See instrument Data Sheet for specific drive and speeds supplied.

1.2 SPECIFICATIONS

TABLE B2. CHART DRIVE CHARACTERISTICS

Driving Sources:
- Spring Types . . . . . Manual or Motor Wound*
- Synchronous Types . . . . Internal (AC-Line Synchronous) Motor*
- Selsyn Types . . . Remote Controlled Internal Selsyn**
- Phantom Types . . Spring or Electric Reroll (Requires External Drive)***

Standard Speeds:
- Inches/Unit Time . . 0.75, 1.5, 3.0, 6.0, 12
- Centimeters/Unit Time 1.25, 2.5, 5.0, 10, 20 (See Table B1)

Power Requirements:
- Electrical Drives/Reroll . . . . See Table B3
- Manual Spring Drives . . . . . None
- Phantom (Spring Reroll) . . . . . None

Dielectric Test . . 1,500V, 60Hz for one minute

Recording Media:
- Inking Charts . . . . 6" X 103' (15mm X 30m)
- Thermal Charts . . . . 6" X 81' (15mm X 24m)
- Channel Width
  - Model A601R, A601C . . . 4-1/4" active span
  - Model A602C . . . . . two 2" active spans
  - Model A609C .one 2-3/4"active analogue span and eight event channels
  - Model A620X, A620T . .twenty event channels

Controls (Optional)
- Power (On-Off) . . . . . Two-Position Switch
- Hour/Minute Selector . . . Two-Position Lever
- Rate Selection . . . . . Manual Change Gears
- Chart Advance (Time Set) . . . . Manual Knob

Remote Control:
- Chart Drive . . External Connections Provided

Attachment:
- External Motor . . . . . See Table B4

* Available with Electric Shift for remote selection of Hour-Minute speeds.
** Available with Back-Up Clutch protection.
*** Available with Drag and/or Back-Up clutches.

NOTE: All drives except Selsyn types may be supplied with a set of manual change gears.

TABLE B3
ELECTRICAL RATINGS

CHART DRIVE TYPE NO.	Internal Motors			Internal Electric Shift Coils				
	AC Volts	Frequency Hz	Load of Drive Motor and Reroll Motor AC (VA)	DC Volts	AC Volts	Frequency Hz	DC Load Watts	AC Load VA
2A	.	. . .	.....	6, 12, 24, 48	6-120	50, 60	1.4[c]	2.4[c]
4	120, 240[a]	50, 60	26	.. ..	.....	.	..	. ....
4A	120, 240[a]	50, 60	26	6, 12, 24, 48	120, 240	50, 60	10[d]	16[d]
6EX	120, 240[a]	50, 60	15	.. ...	. ...	.... .	.....	.....
6EC	120, 240[a]	50, 60	15	.....	.....	.....	. ..	.....
6ECC	120, 240[a]	50, 60	15	.... .	.....	. ....	.....	.....
51	120, 240[b]	50, 60	30	. ...	.. ...	.. ..	. ...	.....
52	120, 240[b]	50, 60	30	.... .	... ..	.....	.....	.....
52A	120, 240[b]	50, 60	30	6, 12, 24, 48	6-120	50, 60	1.4[c]	2.4[c]
55	120	60	25	.....	.....	.....	... ..	.....
56	120	60	26	... ..	.....	.....	.....	.....
56A	120	60	26	6, 12, 24, 48	6-120	50, 60	10[d]	16[d]
60	120	50, 60	75	.....	.....	.. ...	.....	.....
60C	120	50, 60	75	.. ...	.....	.....	.....	.....

[a]Electric chart drives are normally furnished for one voltage only. 120/240 volt, 50 or 60 Hz drives are available. Number 4 drives can also be rated 120/240/480 volt, 60 Hz.

[b]Single voltage ratings only are supplied.

[c]Both AC and DC speed shift coils are designed for continuous operation.

[d]AC speed shift coils are designed for continuous operation. DC speed shift coils should be energized intermittently, not more than five minutes on, followed by equal off period.

TABLE B4
EXTERNAL MOTOR ATTACHMENTS

TYPE	DESCRIPTION	Chart Speeds Inches per Second	Chart Speeds mm per Second	Motor Ratings				
				DC Volts	AC		DC Load Watts	AC Load VA
					Volts	Frequency Hz		
N	Second Speed Non-reset	¾, 1½, 3	12.5, 25, 50, 100	12, 24, 48, 125, 250	120	50, 60	22	60
R	Second Speed, with Time Reset	¾, 1½, 3	12.5, 25, 50, 100	24, 48, 125, 250	120	50, 60	22	60

SECTION 2 — OPERATION

2.1 GENERAL

a. Chart drive operating procedures will vary slightly depending upon the particular type of drive supplied with the recorder. To prepare a typical drive for use, electrical or mechanical connections may be necessary, proper change gears may have to be selected, and the chart paper correctly installed. Basic operating procedures are given on the instruction plate which is attached to the front of each drive.

b. Do not attempt to put the instrument into operation until all instructions have been thoroughly studied. Make sure all items are unpacked and all shipping materials are removed from the instrument. This includes any cardboard or tie-strings that may be securing writing elements, optional change gears, scale-plates, or chart rollers. Failure to make proper connections or to make necessary checks and adjustments may result in unsatisfactory operation or damage to the instrument.

2.2 CONNECTIONS

2.2.1 Electrical

a. All connections for electric drives are made at the rear of the recorder case. Refer to Part C of this manual for specific connection instructions, and to the Data Sheet supplied at the back of this manual for input ratings.

b. Drives equipped with an electric shift to change chart feed rates automatically from hour to minute have a separate pair of terminals on the back of the recorder. Voltage and

frequency of the electric shift feature are not always the same as that of other internal motors.

2.2.2 Mechanical

a. All chart drives, except the selsyn, are equipped with a through driving shaft for external coupling. Selsyn drives also have an external coupling, but it is provided only on the left side of the mechanism. These couplings may be used to either propel the chart from an external source, couple two separate drives for synchronization, or to connect a self-powered drive to a phantom drive--such as in a twin-case recorder.

b. When driving the chart from an external source, a clutch will be provided between the internal drive system and the external coupling shaft. The external power source must be sufficiently large to overcome friction in this clutch---approximately one to two inch-pounds. If rotation of the external source can be reversed, the chart drive must also be equipped with a back-up clutch to prevent the chart from running backward. The back-up clutch is located on the right-hand side of the drive, and therefore the external source must be attached to this side only.

c. Mechanical connections for external sources or for the coupling of two chart drives are made to the ball and cross pin provided on the end of the external coupling shaft. Flexible couplings and extension shafts of various lengths are available from Esterline Angus and may be supplied with the recorder.

NOTE: It is not desirable to couple two synchronous drives. If set to the same time of day and operated from the same source, however, they will stay synchronized.

d. Motor-wound spring drives should not be coupled to each other but may be coupled to the phantom drive in a twin recorder, or to an external driving source. Two hand-wound spring drives may be coupled to synchronize chart timing. The drives must be in good condition and timed accurately, or they may stop. Coupled drives will operate at both hour and minute feeds.

e. The phantom coupling is suitable for coupling the power chart drive in a twin instrument to the phantom chart drive. It is made to spring over the coupling ball fittings and eliminates any lost motion or backlash between the two drives. It is not suitable for transmitting heavy torque and does not take the place of the power couplings, such as those used for external motor drive devices. Excessive torque on a phantom coupling will damage it.

2.3 CHARTING PROCEDURES

a. To maintain guaranteed accuracy and insure optimum performance, always use Esterline Angus precision charts in this instrument.

b. Open the case and see that the chart drive is off. For instruments with front covers hinging at the bottom of the case, remove the cover completely to facilitate preparation for operation. Raise the hinged scaleplate and, if provisions are made, either raise or remove the writing elements. It is also recommended that the measuring system be de-energized. Proceed with the following steps.

WARNING: On instruments having thermal writing elements, avoid direct contact with heated styluses.

(1) Press down on either the right or left reroll latch near the bottom of case and remove reroll roller as shown in Figure B2.

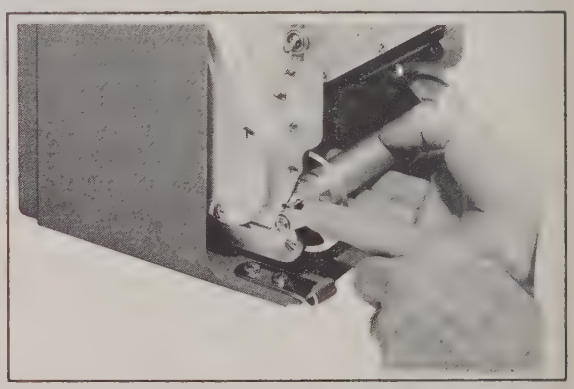


Figure B2.

(2) Remove the chart roll arbor by lifting it up and pulling forward as shown in Figure B3. Center the paper roll on arbor with elongated perforations to right.

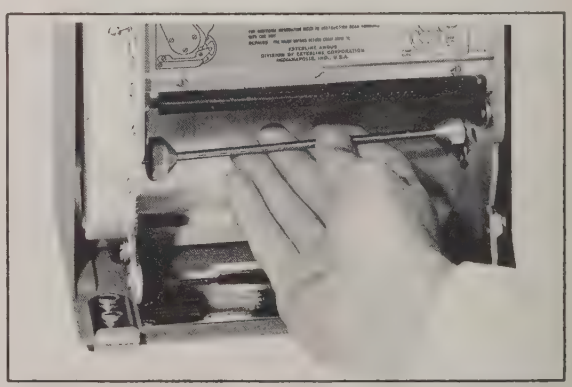


Figure B3.

(3) Snap the ends of the arbor with the new chart into the slots as shown in Figure B4. See that chart supply roll turns freely.

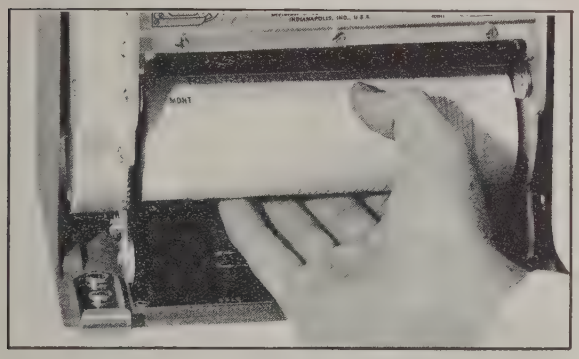


Figure B4.

(4) Tear or cut end of chart into "V" shape. Feed chart into slot marked "INSERT END OF CHART HERE" as shown in Figure B5. Push in until point appears above and behind top drive roller. (Feed under small hold-down roller on Model A601RT only.)

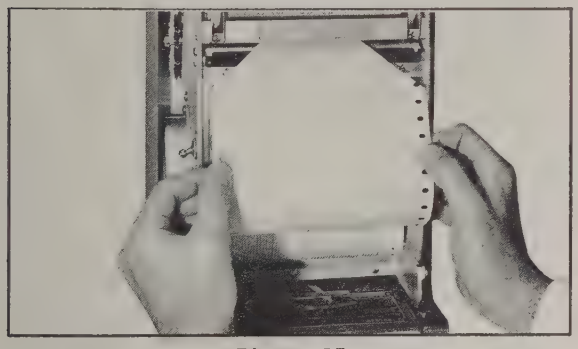


Figure B5.

(5) Feed chart over front of drive roller. Carefully pull the chart down while turning knurled knob at the end of roller, as shown in Figure B6, so roller pins engage chart perforations.

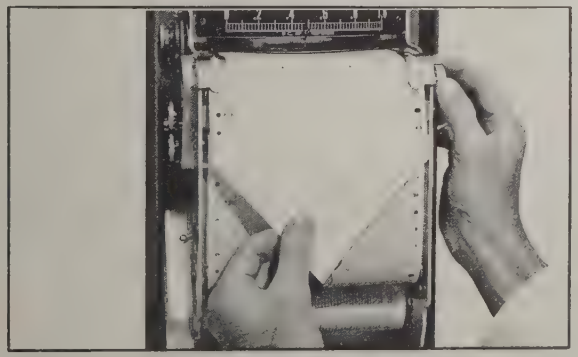


Figure B6.

(6) Snap reroll roller in place (gear end to left) and insert "V" end of chart into roller slot as shown in Figure B7. Turn the reroll roller back 1/4 turn (window blind action). Advance the set knob while permitting chart to reroll.

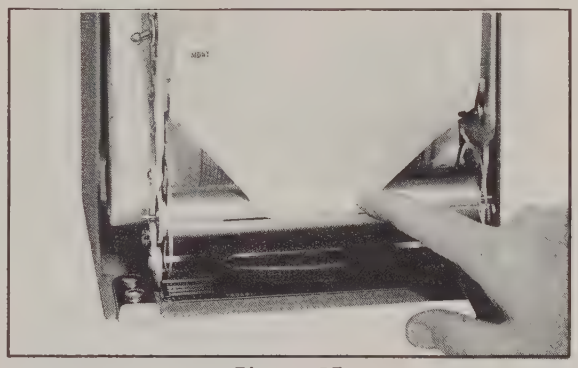


Figure B7.

c. It may be necessary to momentarily energize an electric drive before the reroll will take up the chart. Make sure that the chart is straight and taut. The chart is now installed and ready for operation.

d. A portion of the chart may be unwound from the reroll for inspection by pulling straight out on the chart paper. To stop the reroll action and examine the chart at leisure, release the chart suddenly after a desired length has been pulled from the reroll. This will lock the reroll roller in position. Rewind the chart by pulling it forward slightly and then letting it wind slowly back onto the reroll.

NOTE: To insure accurate recording, always see that the chart paper is straight on the reroll.

e. Instead of rerolling the chart in a conventional manner, provisions may be made for feeding used chart out of the bottom of any instrument case. This is accomplished by removing the rubber strip (or section of gasket) at the lower edge of the case cover or door. The end of the chart hanging out of the case should be weighted; a two-ounce clamp-on device is sufficiently heavy for this purpose. Do not pull or jerk on the end of the chart as this may throw it out of time or disengage the chart from the roller pins.

2.4 CHART REMOVAL

To remove an entire rerolled chart, push down on one of the reroll latches and pull the chart roll forward and out of the instrument. The chart paper may then be removed from the reroll roller by holding the disk at the gear end of

the roller, pulling out the plug from the opposite end, and sliding the chart from the tube. If the chart is wound too tightly, twist the roller counterclockwise as it is being withdrawn from the chart.

2.5 CHANGE GEARS

a. The instruction plate on the front of all standard power drives shows the path traveled by the chart, change gears to use for each standard speed, and how to start and stop the drive. Optional change gears are stored on a clip at the upper left corner of the drive; change gears for special speeds, if any, are stored at the upper right corner.

b. To change gears, proceed as follows:

(1) Hold the lower drive gear with one hand and unscrew two knurled nuts securing drive gear and driven gear to their respective shafts.

(2) Remove gears by pulling straight outward.

CAUTION: Do not pry gears off of shafts.

(3) Install selected gears with keyway in hub engaging key on shaft. Secure gears by hand tightening the knurled nuts.

TABLE B5

STANDARD SPEEDS AND CHANGE GEARS

Chart Speed Inches Per Hour or Minute	Change Gears		Color of Driver & Driven Change Gears
	No. of Teeth (Driver)	No. of Teeth (Driven)	
3/4	18	72	Gold
1-1/2	30	60	Green
3	45	45	Red
6	60	30	Green
12	72	18	Gold
CHART TRAVEL VS. SELSYN ROTATION			
Inches of Chart Travel Per Revolution of Selsyn	Change Gears		Color of Driver & Driven Change Gears
	No. of Teeth (Driver)	No. of Teeth (Driven)	
1/4	18	72	Gold
1/2	30	60	Green
1	45	45	Red
NOTE: See Data Sheet included in the back of this manual for special chart speeds			

2.6 OPERATING PROCEDURES

To put the drive into operation, follow the subsequent instructions that apply to the type of drive used in your instrument. Basic operating instructions are also located in the front plate of each chart drive.

2.6.1 Hand-Wound Spring Drive

a. Raise the control lever on the left side of the chart drive from the stop position to the hour feed mark for hour feeds, or to the minute feed mark for minute feeds. Speed selection can be accomplished by actuating an electromagnet on models equipped with electric shift. AC and DC shift coils for this drive are designed for continuous operation. See the Data Sheet for electrical ratings.

b. A white target, visible through the small window at the left edge of the instruction plate, moves up and down when the drive is running. If the drive does not start immediately, move the control lever up and down a few times. When the chart is started in minute feed, there is a slight lag in getting up to correct speed. This is due to a flyball governor which requires time to reach full speed.

c. Power to operate a hand-wound spring drive is stored in four identical springs connected in series. Phantom chart drives with spring reroll use only two springs. The springs are wound simultaneously.

d. To wind, insert the square end of the winding crank into the winding arbor, push the arbor in as far as it will go and, at the same time, turn steadily in a clockwise direction. When the springs are fully wound, the winding crank will refuse to turn. Be sure the chart drive is fully wound before stopping. A partial turn in the reverse direction, while withdrawing the winding crank, completes the winding operation. The winding arbor is then forced out to its original position by a spring which also disengages the worm from the worm gear inside the housing.

e. If the springs have been unwound completely, it requires about 110 turns of the winding crank to rewind a spring chart drive, or about 55 turns for a phantom drive with spring reroll.

f. The chart is designed to operate for eight days at any of the standard hour feeds. Approximately 65 turns of the crank are required to replace the energy used in eight days' operation. Winding once per week or each time the chart is replaced (whichever occurs first) is recommended. When running the chart at minute feeds, wind the springs every four hours for continuous operation.

2.6.2 Synchronous Motor Drives

a. This type of drive employs two internal motors--a line synchronous motor for timing the chart speed, and a separate induction

motor that powers the reroll mechanism. Electrical input ratings for these motors will be specified on the instrument Data Sheet.

b. HOUR-MINUTE OPERATION: Move the "Start-Stop" switch, located on the left side of the drive, to "ON". Place the hour-minute feed lever, located on the right side of the drive, to the desired position by moving the lever manually or by actuating the electro-magnet on instruments equipped with electric shift. All AC shift coils for hour-minute drives are designed for continuous operation; however, DC shift coils should be energized intermittently--not more than five minutes on, followed by an equal off period.

> CAUTION: Do not energize drive motor and electric shift simultaneously as this may cause the drive to stall.

c. SECOND SPEED OPERATION: On second-speed synchronous drives, the "Start-Stop" switch, located on the left side of the unit, controls only the internal reroll motor. The internal synchronous motor must be controlled by an external switch or relay.

> NOTE: See "Chart Feeder Adjustment" in the maintenance instructions. Fast chart speeds are not recommended for recorders having thermal writing elements.

d. Since a second-speed drive is normally used in the right side of a twin instrument and is coupled to an hour-minute synchronous drive in the left side, the reroll induction motor must operate independently from the internal synchronous motor. An uninterrupted power supply must be furnished for the reroll motor. Separate power-input terminals are provided for each motor.

> NOTE: The drive motor may coast for a period up to 1.5 seconds after power is shut off; consequently, any chart record obtained during this period will not be accurately timed.

2.6.3 Motor-Wound Spring Drives

a. Move the switch on the right side of the drive to its "ON" position, then raise the control lever on the left side from its stop position to the hour feed mark for hour feeds, or to the minute feed mark for minute feeds. Speed selection can be accomplished by actuating an electromagnet on instruments equipped with electric shift. AC and DC shift coils for this drive are designed for continuous operation. Electrical ratings for the drive motor and shift coil will be specified on the instrument Data Sheet.

b. If storage springs are unwound, the push-button on the right side of the drive must be held down for approximately one-and-a-half minutes to rewind the springs. A white target, visible through the small window at the left edge of the instruction plate, moves up and down when the drive is running. If the drive does not start immediately, move the control lever up and down a few times. When the chart is started in minute feed, there is a slight lag in getting up to correct speed. This is due to a flyball governor which requires time to reach full speed.

2.6.4 Selsyn Drive

a. Power to a selsyn chart-drive system is supplied by the user. These drives are operated by an internal selsyn receiver. Chart feed rates provided by this drive are given in Table B5 under "Change Gears."

> CAUTION: Selsyn speed should not exceed an RPM which corresponds to a chart speed of 12 inches per minute for satisfactory inkless recording.

b. The motor for an electric reroll in a selsyn drive is rated at 120 volts, 60Hz. See the instrument Data Sheet for recommended electrical ratings. When required, a connection diagram for transmitting and receiving selsyns will be supplied in the Appendix of this manual. Refer to the special supplement on selsyn devices for additional operating instructions.

2.6.5 Phantom Chart Drive

The chart in this type of drive is propelled by an outside source, however, they do have their own system for reroll. To activate the reroll on electric reroll models, move the power switch on the left side of the drive to "ON". It is necessary only to wind the spring on models with spring reroll. See "Hand-Wound Spring Drive" in this section for spring winding instructions. If an electric reroll is supplied, refer to the instrument Data Sheet for power ratings.

2.7 EXTERNAL MOTOR ATTACHMENTS

a. An external motor attachment consists of a fractional horsepower motor and gear box which mounts on the right side of the recorder case and couples to the internal drive system. Fast chart speeds are obtainable with this attachment.

> CAUTION: High chart speeds are not recommended for recorders having thermal (inkless) writing elements.

b. Optional change gears supplied with the internal drive determine the chart speed. The

external motor moves the chart 3600 times the normal hour speed. Usually, 3/4 inch per second is recommended, as this speed is high enough to record any variations that the recorder can follow. Electrical power must be maintained to the internal synchronous, motor-wound spring, and electric phantom chart drives to assure continuous reroll action.

c. Instruments supplied with a high-speed motor attachment will require more careful attention than those operating at slow chart speeds. For example, it is recommended that the recorder inking system be flushed and cleaned much more often than normally required, and that the pen pressure (weight) always be sufficient to hold the pen on the chart during high-speed operation. The chart paper must also be kept clean and dry; it must be properly threaded and rerolled straight on the reroll roller. It is a good practice to keep the case cover or door closed whenever possible.

2.7.1 Style 24 (Type N)

This external motor drive is a non-reset type. To start the chart operating at high speed, it is only necessary to energize the external motor. This can be done with the switch on the top of the gear box, or this switch can be left in the "on" position and the motor started by closing another switch or a pair of relay contacts at some remote point. The chart continues to move at high speed as long as the motor is energized and stops when it is de-energized.

2.7.2 Style 22 (Type R)

a. This external motor drive operates in the same manner as Type N, except that it resets the chart to the correct time of day after each high-speed operation. It must be energized from an unfailing power supply.

b. On this drive, the chart is started operating at high speed when the external motor is energized by a pair of relay contacts. When the trip circuit is de-energized, a lock-in circuit causes the motor to continue running until the chart is again set for the correct time of day. To insure lock-in, the trip circuit must remain closed for approximately 1/5 second. For test purposes, a spring-loaded test switch located on the top of the gear box will also start the drive.

SECTION 3 — MAINTENANCE

3.1 GENERAL

The chart drive is a very important part of a graphic recording instrument. The drive system must move the chart consistently at the correct speed under all conditions. The drive selected for use in the recorder converts either electrical or mechanical energy into linear physical motion of the chart paper. Refer to the Data Sheet in this manual for the chart drive supplied, and to Table B6 for a description of the specific type and factory style number.

3.2 ROUTINE MAINTENANCE

a. The components employed in each chart drive assembly are of sturdy construction and are designed for long trouble-free operation. Nevertheless, they should receive the care afforded any precision piece of equipment to extend their useful life. Should adjustment or minor service become necessary in the field, refer to the following maintenance procedures. In the few cases where major repairs are necessary, contact your local Esterline Angus representative for instructions.

WARNING: To prevent accidental shock, always remove power from the instrument before disassembling or servicing.

b. Periodic maintenance schedules should be established which include inspecting, cleaning, adjusting, and lubricating. A recorder operating continuously (24 hours daily) should be inspected and lubricated once a year. A recorder used periodically should undergo a visual inspection and lubrication once every three years.

3.2.1 Inspection

a. Visual inspection of the chart drive should be made at each maintenance period with particular attention to the following:

(1) Accumulation of dirt or other foreign material on outer surfaces or within the drive mechanisms.

(2) Misadjusted chart guides or damaged control levers.

(3) Loose screws, couplings, nuts, or other hardware.

TABLE B6

SERIES "A" CHART DRIVES

CATALOG TYPE NUMBER	CHART DRIVE DESCRIPTION	FACTORY STYLE NO. APPLICABLE RECORDER MODELS			
		A601C, A602C A609C, A620X	A601R*	A601RT	A620T
1	Hand-wound Spring, Hour Speeds Only	80-H	83-H	85-H	80-HT
2	Hand-wound Spring, Hour and Minute Speeds	80-M	83-M	85-M	80-MT
2A	Hand-wound Spring, Hour and Minute Speeds with Electric Shift	180-MS	83-MS	85-MS	180-MST
4	Synchronous Motor, Hour and Minute Speeds**	190-M	93-M	95-M	190-MT
4A	Synchronous Motor, Hour and Minute Speeds with Electric Shift	190-MS	93-MS	95-MS	190-MST
6X	Phantom, Spring Reroll, without Clutches	81-P	83-P	86-P	81-PT
6C	Phantom, Spring Reroll, with Drag Clutch	82-P	84-P	87-P	82-PT
6CC	Phantom, Spring Reroll, with Drag and Back-up Clutches	82-PC	84-PC	87-PC	82-PCT
6EX	Phantom, Electric Reroll, without Clutches	191-P	93-P	95-P	191-PT
6EC	Phantom, Electric Reroll, with Drag Clutch	192-P	94-P	96-P	192-PT
6ECC	Phantom, Electric Reroll, with Drag and Back-up Clutches	192-PC	94-PC	96-PC	192-PCT
51	Motor-wound Spring, Hour Speeds Only	201-H	104-H	105-H	***
52	Motor-wound Spring, Hour and Minute Speeds	201-M	104-M	105-M	***
52A	Motor-wound Spring, Hour and Minute Speeds with Electric Shift	201-MS	104-MS	105-MS	***
55	Synchronous Motor, Second Speed Only	190-B	93-B	***	190-BT
56	Synchronous Motor, Hour and Minute Speeds, USED ONLY WITH 55 DRIVE	190-S	93-S	***	190-ST
56A	Synchronous Motor, Hour and Minute Speeds with Electric Shift, USED ONLY WITH 55 DRIVE	190-SS	93-SS	***	190-SST
60	Selsyn	202	103	106	202-T
60C	Selsyn with Back-up Clutch	202-C	103-C	106-C	202-CT

* An additional "-2" suffix to the Style No. indicates a cartridge-type inking system.

** A "-MMR" Style No. suffix indicates multi-range for operation on both 120 and 240 volts AC.

*** Style available but not recommended for this application.

(4) Evidence of excessive wear in moving parts of the drive.

(5) Damaged wiring, loose connections, or defective switch.

b. If any of the above are evident, corrective measures should be taken without delay.

3.2.2 Cleaning

a. Dirt, dust,or other foreign bodies are not conducive to long life of working parts, and precautions should be taken to prevent admission of these substances into the chart drive assemblies. Regardless of the precautions taken, dirt will enter the case and therefore the chart drive should be cleaned periodically--depending upon environmental conditions.

b. Remove chart paper, reroll roller, supply arbor, change gears, and front instruction plate before cleaning. All surfaces should be carefully cleaned using a soft-bristled brush or low vacuum system. Mild soap or detergent may be used to clean rollers and to wipe off all outer surfaces of the drive.

CAUTION: Do not disturb mechanical alignment of parts or routing of wiring during cleaning procedures.

c. Ink or other liquids, if spilled on the chart drive mechanism, should be removed promptly. EA recording ink is water-based and may be removed with a wet cloth. Other liquids must be removed by means appropriate to their nature.

d. Dirt may be removed, especially when lodged in lubricating grease,by use of a suitable brush and a mild solvent--such as benzine. Harsh solvents such as acetone or paint brush reconditioners should not be employed. When a solvent has been used, parts should be allowed to dry thoroughly before a lubricant is applied.

CAUTION: Do not use excessive amounts of cleaning solvents on oil-impregnated bearings.

3.2.3 Lubrication

a. The chart drive should undergo a thorough cleaning before lubricating. The lubricants specified in this manual are for use on drives operating at average temperatures from 20° to 100°F. If a drive is to be operated in temperatures outside of this range,special lubricants may be required (consult the factory).

CAUTION: Allow sufficient time for cleaning solvents to dry before lubricating parts. DO NOT over lubricate.

b. BEARING PLATES: All chart drive bearings should be oiled as illustrated in Fig. B8. Use EA 40 Oil on all impregnable bearings, and heavy-weight Nonpareil Oil on all other bearings--except in escapements. Do not oil ratchets and pawls; they operate better when dry.

c. GEARS AND SPRINGS: All gear teeth should be lubricated with EA Mainspring Grease as shown in Fig. B8. The mainsprings employed in a spring chart drive should also be lubricated with this grease. Mainsprings will seldom require regreasing; however, when spring lubrication is necessary, the drive must be partially disassembled. It is recommended that this work be done in a meter repair shop or the entire unit be returned to Esterline Angus for factory service.

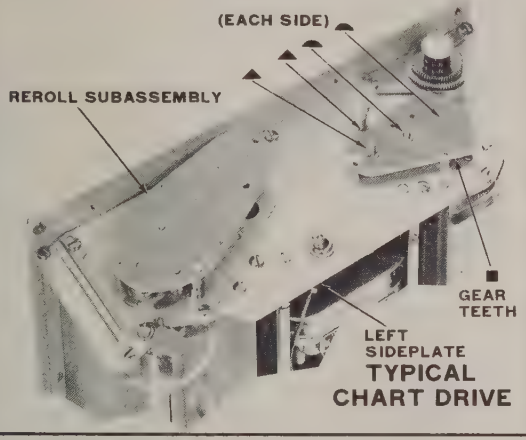
d. ELECTRIC MOTORS: Bearings of reroll or spring-winding motors should be lubricated with EA 40 Oil once a year. Hour-minute synchronous motors, selsyn units, and EA external motors are lubricated for life; do not attempt to relubricate.

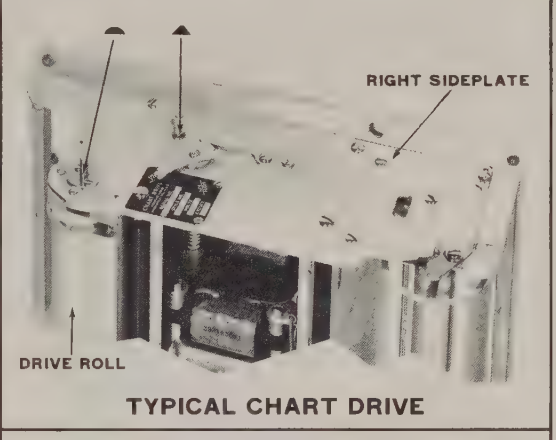
e. The gear trains associated with an external motor attachment may be oiled from a single lubrication point located on top of the external gear box. Use EA 40 Oil for this application. Internal second-speed motors should be oiled with medium-weight Nonpareil Oil (#0966) every six months. Add ten drops of oil to each red hole in the motor. Remove the chart feeder plate from the top of the drive; the oiling holes are then accessible by means of a long-spouted oil can.

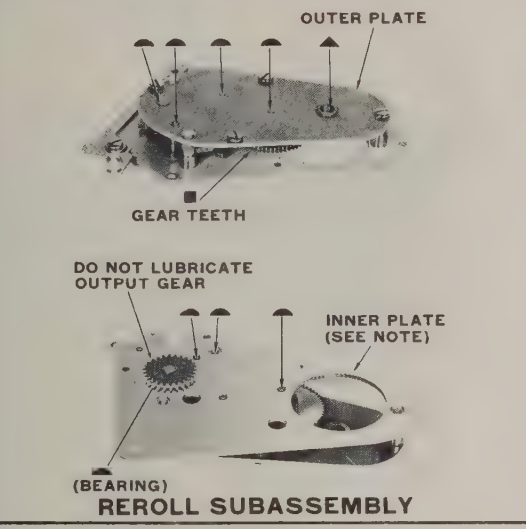
f. ESCAPEMENTS: Clock escapements employed in spring chart drives must be lubricated with Nye's Superior Clock Oil only. Always see that the mechanism is clean before applying the lubricant. Oil all bearing points as illustrated in Fig. B8. A small quantity of EA Mainspring Grease should also be applied to the teeth of each escapement gear. Do not oil ratchets and pawls; they operate better when dry.

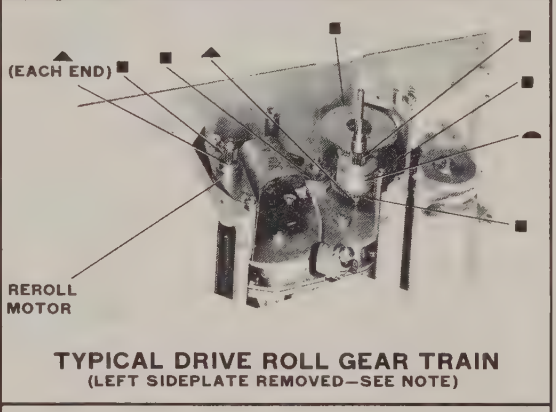
3.3 CHART GUIDE ADJUSTMENTS

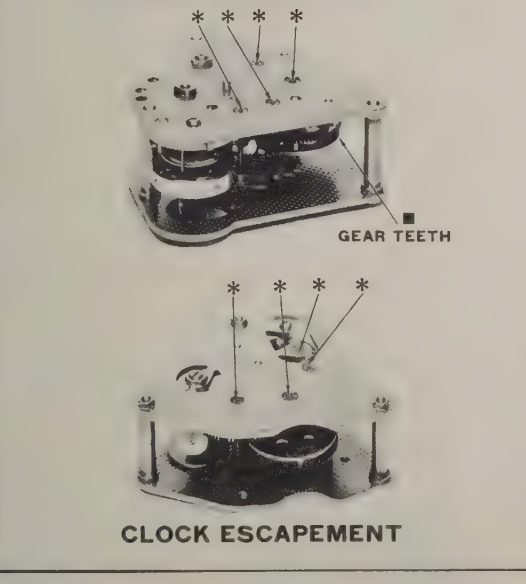
a. The chart guides are properly adjusted at the factory and their positions normally should not be changed. However, if the drive has been subjected to rough handling or disassembled, readjustments will be necessary.

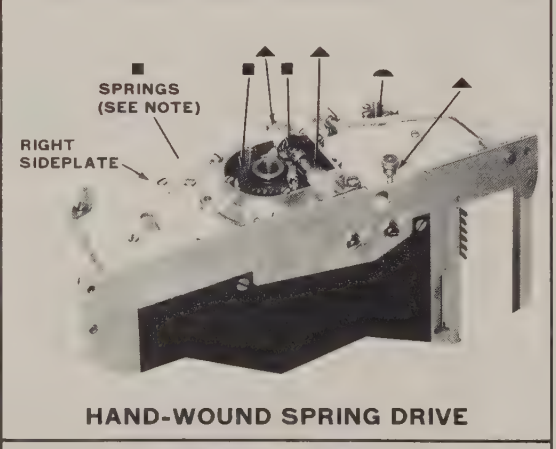












LUBRICATION TABLE

SYMBOL	LUBRICANT	PART NO.	PROCEDURE
▲	EA 40 OIL (1 OZ. WITH APPLICATOR)	0918	ONE SMALL DROP APPLIED WITH WIRE APPLICATOR.
▬	NONPAREIL HEAVY-WEIGHT OIL (4 OZ.)	0967	ONE SMALL DROP APPLIED WITH WIRE APPLICATOR
	WIRE APPLICATOR (ONLY)	5775	
■	EA MAINSPRING GREASE (4 OZ.)	01	APPLY SPARINGLY.
*	NYE'S CLOCK OIL (1/4 OZ. WITH APPLICATOR)	0917	ONE SMALL DROP APPLIED WITH WIRE APPLICATOR.

NOTE:
REQUIRES DISASSEMBLY THAT SHOULD BE PERFORMED ONLY BY QUALIFIED PERSONNEL.

Figure B8. Chart Drive Lubrication Points.

b. The correct position of the chart guides is evident when there is no tendency of the paper to be depressed into the grooves on the drive roll. The turned down edge "A", Fig. B9, should follow the contour of the drive roll but allow clearance for the chart paper, so that there is no drag on the paper. It may be necessary to loosen two screws "B", Fig. B10, in order to facilitate this adjustment. Screw "C" may also be loosened, when necessary, to provide parallel positioning of chart guides with relation to the side plates.

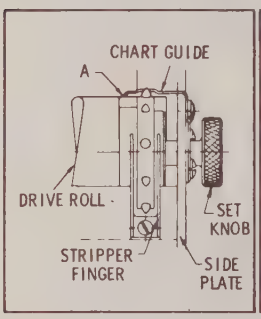


Figure B9. Chart Guide (Front View).

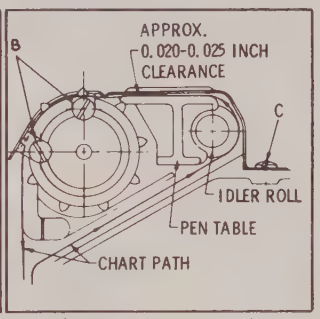


Figure B10. Guide Adjustment (Side View).

3.4 RECORDING TIMETABLE

Esterline Angus charts are currently available in useful lengths of 103 feet (Ink Types); and 81 feet (Thermal Types). The total running time for any chart will, of course, depend upon the chart speed employed. Chart running times for various chart speeds are shown in the following table.

STANDARD (INCH) CHART SPEEDS	CONTINUOUS RUNNING TIME* (MIN.)	
	INK CHARTS	THERMAL CHARTS
3/4 In/Hr.	65-2/3 Days	51 Days
1-1/2 In/Hr.	32-1/3 Days	25-1/2 Days
3 In/Hr.	15-2/3 Days	12-3/4 Days
6 In/Hr.	7-1/3 Days	6-3/8 Days
12 In/Hr.	3-2/3 Days	3-3/16 Days
3/4 In/Min.	26-2/3 Hrs.	20-4/5 Hrs.
1-1/2 In/Min.	13-1/3 Hrs.	10-2/5 Hrs.
3 In/Min.	6-2/3 Hrs.	5-1/5 Hrs.
6 In/Min.	3-1/3 Hrs.	2-3/5 Hrs.
12 In/Min.	1-2/3 Hrs.	1-3/10 Hrs.
3/4 In/Sec.	26-2/3 Mins.	20-3/4 Mins.
1-1/2 In/Sec.	13-1/3 Mins.	10-3/8 Mins.
3 In/Sec.	6-2/3 Mins.	5-3/16 Mins.

* All calculations take into consideration 3 feet of chart for installation. Charts for Hour Speeds also allow for the loss of an entire 24 hour period, so that they may always be set to the time of day.

3.5 CHART DRIVE SERVICING

3.5.1 Synchronous

a. Each synchronous chart drive contains two electric motors - the synchronous timing motor and an induction motor driving the reroll. Removal of these motors will require major disassembly and should be done only at the factory or in a well-equipped instrument shop.

b. The reroll gear train may be replaced as a complete unit; or, the reroll storage spring assembly only may be replaced. In either case, be sure to "let down" the reroll spring before attempting disassembly. With power off, hold the chart reroll roller in the hand and let it revolve slowly until it turns no longer. Damage may result if disassembly is attempted with energy stored in the spring.

3.5.2 Hand-Wound Spring

a. Before attempting any repair work on this chart drive, the springs must be completely unwound. If this is not done, spring power may be released suddenly and cause damage to the chart drive or injury to the operator.

b. UNWINDING THE SPRINGS: To let down or unwind the springs, take the chart drive out of the case per "Disassembly" instructions. Do not replace the chart reroll. Remove the reroll gear cover by removing the four screws holding it in place. Lay the drive on its back. Insert the winding crank with one hand and push the reroll release pin to the left with the other. This pin projects out of the left-hand sideplate. Its location is shown on the instruction plate. The release pin will slide easily if the crank is held so that the pressure on the pin is relieved. Do not force the pin. Holding firmly to the winding crank, allow it to turn slowly in a counterclockwise direction until the springs are completely unwound. Springs are unwound when the crank no longer tries to turn. Do not let go of crank until the springs are unwound. When servicing is completed, push the reroll release pin to the right (to its original position), replace the reroll gear cover, and wind the springs as required.

c. REPLACING THE SPRINGS: Let down the springs; see "Unwinding the Springs" instructions. Take off the winding bracket by removing the four screws which hold it to the right sideplate. With the instruction plate off, the spring assembly can be withdrawn through the hole in the right sideplate. New spring assemblies may be installed and the winding bracket replaced. The springs are now ready for winding.

d. THE ESCAPEMENT: A hand-wound spring chart drive is timed by one of three escapements. The hour-feed escapement will provide only hour feeds. The minute-feed escapement contains both the hour-feed timing mechanism and a flyball governor to time minute feeds. An hour-feed chart drive can be changed to minute feed by changing escapements. The third type of escapement is used in drives equipped with an electric shift for automatic change from hour to minute feeds.

NOTE: Repair of escapements, except at the Esterline Angus factory, is not recommended. For repair, install a spare escapement in the instrument and return the worn one to the factory for servicing. When ordering new escapements, include the part number located on the left sideplate of the old escapement.

e. ESCAPEMENT REMOVAL: The escapement assembly can be removed without major chart drive disassembly. First, follow instructions under "Unwinding the Springs." Next, remove the control lever and three screws holding the escapement to the left-hand sideplate of the drive. The escapement is accurately positioned by two dowell projections on the plate. This insures correct mesh of the gear which drives the escapement with the pinion in the escapement. Grasp the right-hand plate of the escapement with a pair of flat-nosed pliers and carefully pull the escapement off of the dowels.

CAUTION: Always let down reroll spring before attempting to remove escapement.

f. CHART TIMING REGULATION: To regulate the hour-feed timing, move the regulator lever either up to make the drive run faster, or down to make it run slower. The regulator lever is visible through the slot in the front instruction plate. Although not all escapements respond alike, a movement of one division on the regulator scale affects the timing approximately four minutes a day. The regulation of chart speed on minute feeds is accomplished by turning the small screw located above the control lever on the escapement. The direction to turn for a faster or slower adjustment is shown by the arrows. This adjustment is very sensitive. Turn the screw slightly, permit mechanism to reach full speed, and note the effect on chart speed by using a timepiece and measuring how much chart is fed during a given period.

3.5.3 Motor-Wound Spring

a. The power to wind the mainspring of this type of drive is supplied by an internal induction motor. Another identical motor rerolls the used record chart as required. Both motors are energized periodically by means of a cam-operated switch. At any standard hour feed, the motor-wound spring drive will operate for five hours without electrical power.

NOTE: Should actuation of the cam-operated switch result in undesirable electrical interference, connect a .25mfd @ 600V capacitor in parallel with a 2000 ohm, 10-watt resistor across the switch terminals.

b. Before undertaking any repair work on this chart drive, the springs must be completely unwound. Failure to unwind the springs will release power suddenly and damage the chart drive. To unwind the mainspring, first turn off the power supply switch, then remove the instruction plate from the front of the drive. Next, find the copper colored detent located below the power switch on the inside of the right sideplate. Push in on the tail of this detent and allow the spring to unwind until the gearing stops turning. This spring unwinds rather slowly, so be sure to allow enough time for it to become completely unwound.

c. The reroll storage spring must also be unwound before removing the reroll train. Let the reroll roller turn slowly in the hand until the spring is completely run down.

d. The escapements used in motor-wound chart drives are similar to those used in hand-wound chart drives. Refer to servicing procedures in the "Hand-Wound Spring" section.

3.5.4 Phantom

a. The phantom chart drive is propelled by a source of power external to the drive. This external source is commonly a self-powered chart drive installed in one side of a twin recorder;the phantom drive is installed in the other side and is directly coupled to the powered drive.

b. When the application of a phantom drive requires that it be driven from some external shaft or motor instead of a powered chart drive, the driving member should be attached to the coupling shaft by means of a flexible coupling. The ends of the coupling shaft are fitted with a ball and cross pin which engages the slotted coupling head. Esterline Angus can furnish a variety of couplings or simply a coupling head so that the user may make up his own coupling shaft for a specific application.

c. All phantom drives have their own power for rerolling the used record chart. Two types are used: electric reroll and spring reroll. In phantom drives with electric reroll, reroll

power is provided by an internal induction motor which winds a storage spring. The spring transmits the power to the reroll. When the power to the reroll motor fails, the reroll storage spring has the capacity to wind up eighteen inches of used chart.

d. The reroll gear train may be replaced as a complete unit; or, the reroll storage spring only may be replaced. In either case, be sure to let down the reroll spring before attempting disassembly. With power off, hold the chart reroll roller in the hand and let it revolve slowly until it no longer turns. Damage may result if disassembly is attempted with energy stored in the spring.

e. In phantom drives with spring reroll, reroll power is supplied by internal hand-wound springs. The spring and reroll train assemblies are similar to those used in hand-wound spring drives. See "Unwinding the Springs" and "Replacing the Springs" under the "Hand-Wound Spring" section for servicing procedures.

3.5.5 Selsyn

a. Selsyn chart drives are operated by a General Electric (120 volts, 60Hz) Selsyn receiver. Power to operate the reroll of a selsyn drive is provided by a separate induction motor which winds a storage spring. This spring transmits power to the reroll roller.

b. The reroll gear train may be replaced as a complete unit; or, the reroll storage spring assembly only may be replaced. In either case, be sure to let down the reroll spring before attempting disassembly. With power off, hold the chart reroll roller in the hand and let it revolve slowly until it no longer turns. Damage may result if disassembly is attempted with energy stored in the spring. Refer to the separate supplement supplied with this manual for complete instructions on selsyn devices.

3.6 DISASSEMBLY

a. The chart drive assembly may be removed from the instrument case as a single unit except for recorders having rectigraph writing systems. For these recorders, the entire chassis must be removed; refer to the disassembly instructions in Part C of this manual for removal procedures.

WARNING: Remove power from instrument before disassembling or servicing.

b. Removal Procedures:

(1) Open the case cover or door and see that the chart drive is off.

CAUTION: Before attempting to remove the chart drive from a twin case, the drive coupling must be disconnected by pushing the coupling endwise as far as it will go. If pushed to the right, the left-hand unit may be removed. Do not pull the drive out at an angle to disconnect the coupling. This may damage both the drive and the coupling.

(2) From the front of the instrument, remove the four screws securing the chart drive at each corner of its rear mounting plate.

NOTE: When applicable, disconnect external drive couplings and raise or remove the writing elements.

(3) Lift the entire drive assembly out from the front of the case.

CAUTION: On electrical drives, unplug the lead connector(s) at the rear of the drive before attempting to completely remove the assembly.

3.7 TROUBLESHOOTING

The simplified troubleshooting guide presented in Table B7 may be used when minor chart drive troubles occur in the field. This table describes the most common troubles, lists the most frequent causes, and suggests the most likely remedy procedures. Refer to Part C of this manual for troubleshooting instructions dealing with other systems of the recorder.

3.8 REPLACEMENT PARTS

All parts for Series "A" chart drives are made available directly from Esterline Angus. When ordering parts, always give part numbers and instrument serial number. Refer to the illustrations in this manual for parts identification.

TABLE B7

CHART DRIVE TROUBLESHOOTING GUIDE

TROUBLE SYMPTOM	PROBABLE CAUSE	SUGGESTED REMEDY
Drive inoperative	Improper adjustment	See that levers or switches are properly set (refer to para. 2.6).
	Change gears incorrectly installed.	See that gear hub engages shaft (refer to para. 2.5b).
Drive inoperative (Spring types only)	Loss of power	See that spring is properly wound (refer to para. 2.6.1d).
Drive inoperative Electric types only).	Loss of power	Check power source, connectors, wiring, switch, and motor. (See Figure B11.)
Drive inoperative (Phantom types only).	Loss of power	Check driving source and mechanical couplings.
Reroll inoperative (drive functions).	Loss of power	Check reroll power source.(See Figure B11.)
	Bent disk on left end of reroll roller.	Straighten disk or replace roller assembly.
Hour-minute shift inoperative (manual type).	Defective shift spring	Remove instruction plate and check spring. Replace if necessary.
Hour-minute shift inoperative (electric type).	Loss of power.	Check power source, wiring, connections, and shift coil.(See Figure B11.)
Chart speeds are uneven (erratic).	Change gears incorrectly installed or binding.	See that gears engage shafts and that nuts are tight. Replace gears if bent or broken.
	Defective power source (Electric drives only)	Check power source and connections. (See Figure B11.)
Chart speeds are too fast or too slow.	Improper timing regulation (Escapement drives only).	Adjust timing regulation (refer to para. 3.5.2f).
	Incorrect power source (Synchronous drives only).	Check voltage and frequency ratings. (See Data Sheet).
Paper will not completely thread into drive when charting.	Threading path obstructed	Remove small bits of paper which may collect under rear of chart feeder and guides. Check clearance of chart feeder.
Leading edge of holes in chart paper tear	Chart paper binding	See that supply arbor turns freely and that chart is correctly installed.
Chart paper wrinkles	Chart guides not aligned properly.	Adjust chart guides (refer to para. 3.3b).
	Improper reroll action	Straighten paper on reroll roller and check reroll power source.
Excessive noise from drive.	Mechanical part binding, loose, or broken.	Check all moving parts. Replace if necessary.
	Lack of lubricant	Follow lubricating instructions in para. 3.2.3.

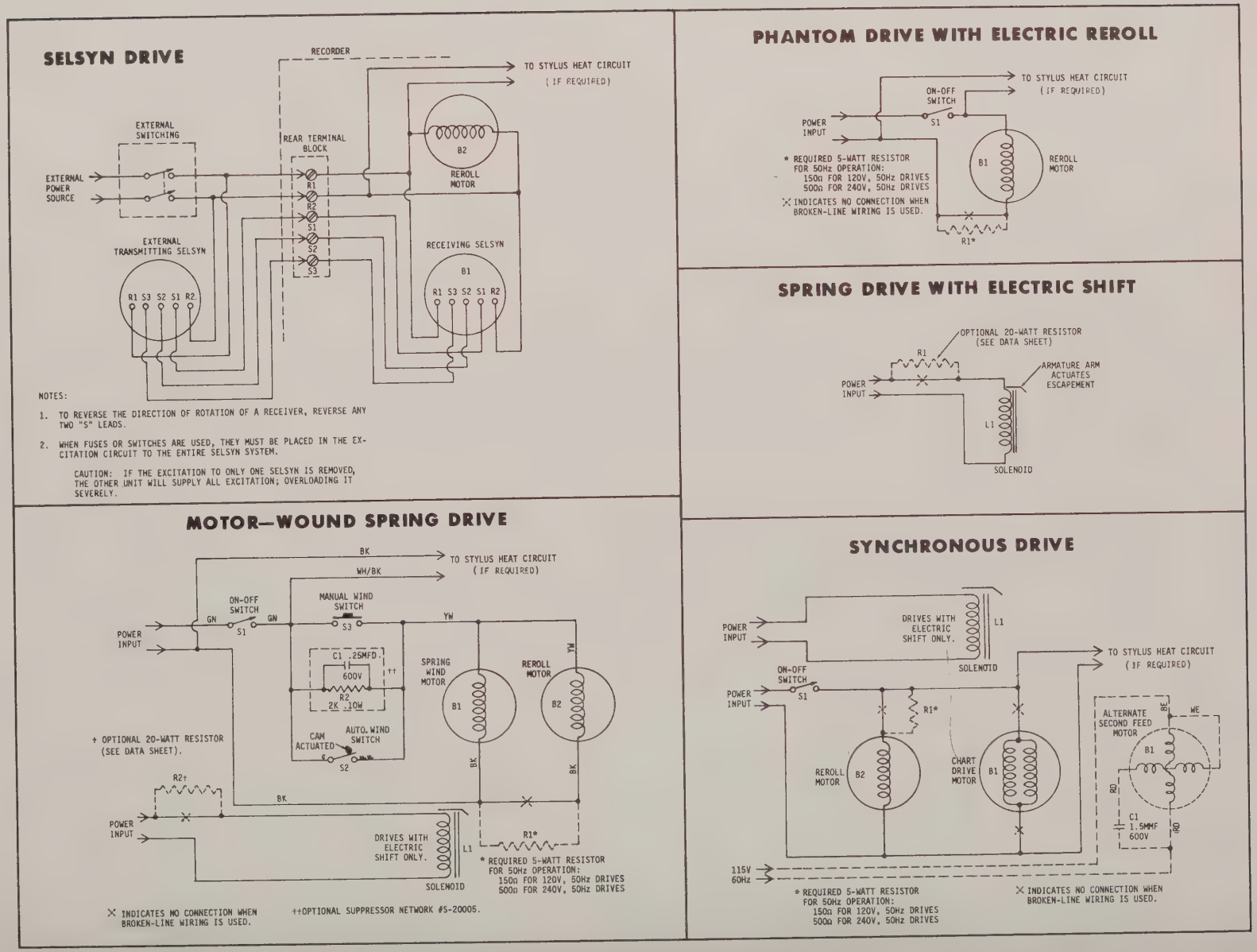
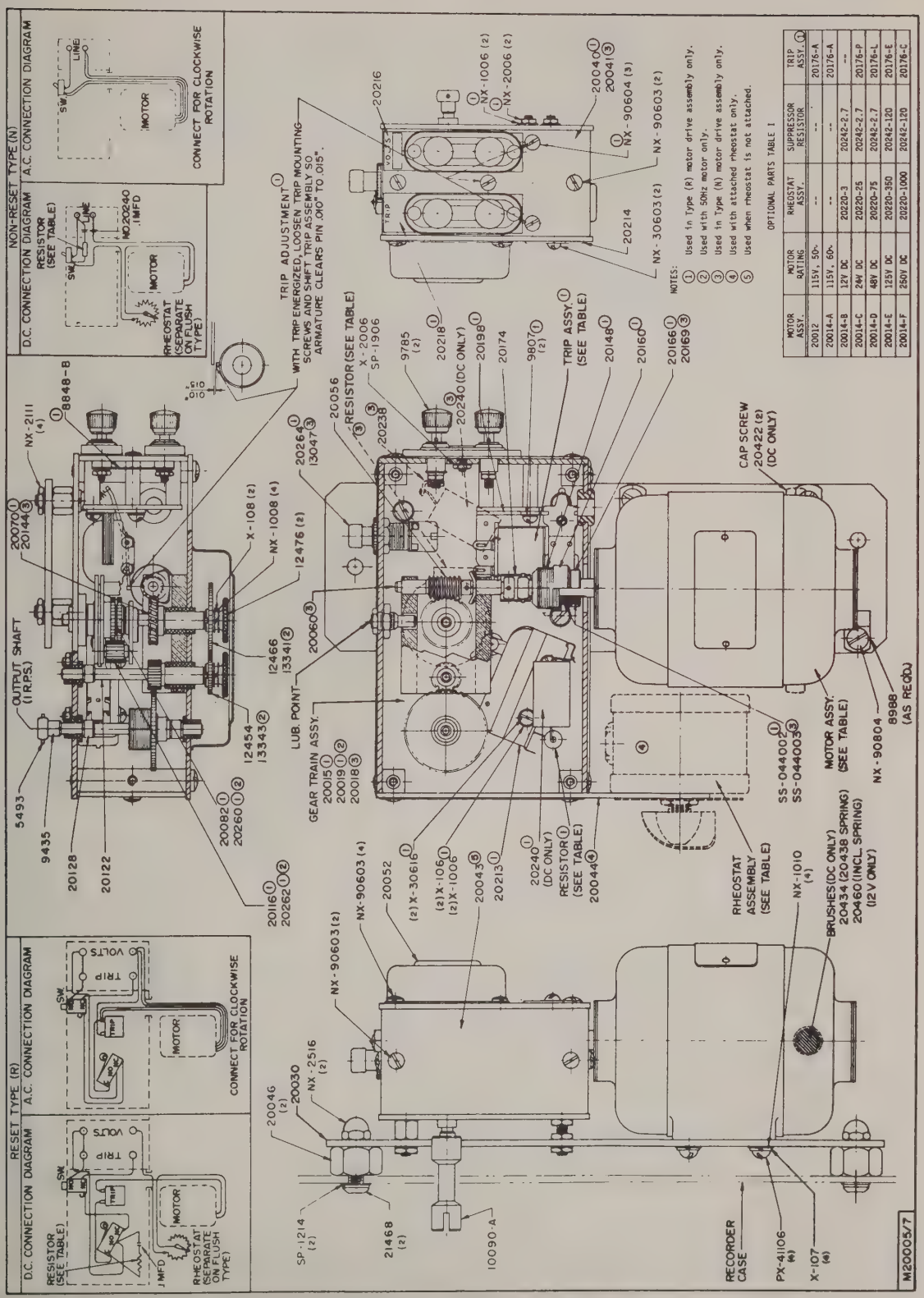


Figure B11. Chart Drive Power Wiring Diagrams.


RESET TYPE (R)
D.C. CONNECTION DIAGRAM
A.C. CONNECTION DIAGRAM
RESISTOR (SEE TABLE)
RHEOSTAT (SEPARATE ON FLUSH TYPE)
CONNECT FOR CLOCKWISE ROTATION
NON-RESET TYPE (N)
D.C. CONNECTION DIAGRAM
A.C. CONNECTION DIAGRAM
RESISTOR (SEE TABLE)
RHEOSTAT (SEPARATE ON FLUSH TYPE)
CONNECT FOR CLOCKWISE ROTATION
TRIP ADJUSTMENT
WITH TRIP ENERGIZED, LOOSEN TRIP MOUNTING SCREWS AND SHIFT TRIP ASSEMBLY SO ARMATURE CLEARS PIN .010" TO .015".
OUTPUT SHAFT (1 R.P.S.)
LUB. POINT
GEAR TRAIN ASSY.
RESISTOR (SEE TABLE)
TRIP ASSY. (SEE TABLE)
RHEOSTAT ASSEMBLY (SEE TABLE)
MOTOR ASSY. (SEE TABLE)
CAP SCREW 20422 (2) (DC ONLY)
BRUSHES (DC ONLY) 20434 (20438 SPRING) 20460 (INCL. SPRING) (12 V ONLY)
RECORDER CASE
NOTES:
① Used in Type (R) motor drive assembly only.
② Used with 50hz motor only.
③ Used in Type (N) motor drive assembly only.
④ Used with attached rheostat only.
⑤ Used when rheostat is not attached.
OPTIONAL PARTS TABLE I
M20005/7

MOTOR ASSY.	MOTOR RATING	RHEOSTAT ASSY.	SUPPRESSOR RESISTOR	TRIP ASSY. ①
20012	115V, 50~	--	--	20176-A
20014-A	115V, 60~	--	--	20176-A
20014-B	12V DC	20220-3	20242-2.7	--
20014-C	24V DC	20220-25	20242-2.7	20176-P
20014-D	48V DC	20220-75	20242-2.7	20176-L
20014-E	125V DC	20220-350	20242-120	20176-E
20014-F	250V DC	20220-1000	20242-120	20176-C

Figure B12. EXTERNAL MOTOR ATTACHMENTS.

PARTS TABLE I

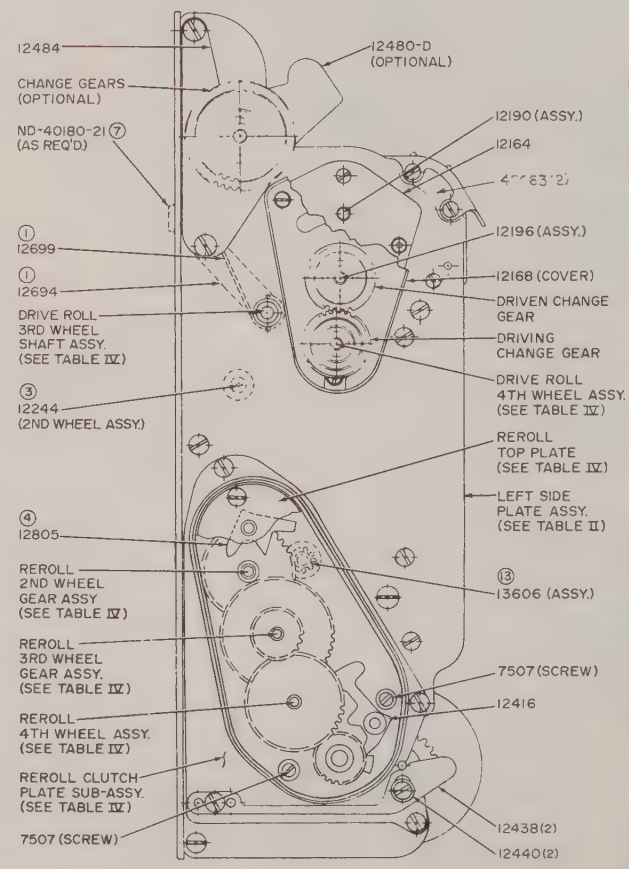
CHART DRIVE STYLE NUMBER	MOUNTING PLATE SUB-ASSY.
80-H/-M; 81-P; 82-P/-PC; 190-M/-MMR/-MS/-S/-SS; 191-P; 192-P/-PC; 201-H/-M	12125
83-H/-M/-P; 84-P/-PC; 93-B/-M/-MS/-P/-S/-SS; 94-P/-PC; 104-H/-M	21415
83-H-2/-M-2/-P-2; 84-P-2/-PC-2; 93-B-2/-M-2/-MS-2/-P-2/-S-2/-SS-2; 94-P-2/-PC-2; 104-H-2/-M-2	21414
85-H/-M; 86-P; 87-P/-PC; 95-M/-MS/-P; 96-P/-PC; 105-H/-M	46441
80-HT/-MT; 81-PT; 82-PCT/-PT; 190-MST/-MT/-SST/-ST; 191-PT; 192-PCT/-PT	17328
83-MS; 104-MS	21416-1
83-MS-2; 104-MS-2	21416-2
85-MS; 105-MS	21416-3
180-MS; 201-MS	12013
190-B	13810
190-BT	17326
103/-C	21418-1
103-C-2/-2	21418-2
106/-C	46442
180-MST	17329
202/-C	13662
202-CT/-T	17327

PARTS TABLE II

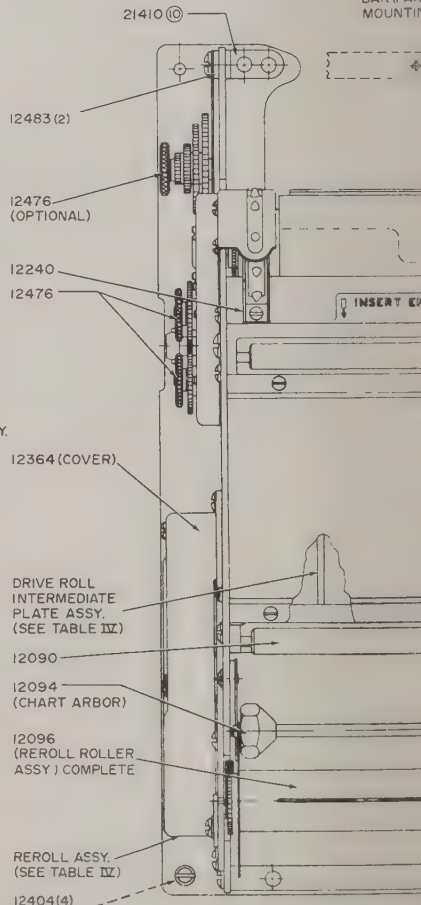
CHART DRIVE STYLE NUMBER	LEFT SIDE PLATE ASSY.
93-B/-B-2/-M/-M-2/-MS/-MS-2/-P/-P-2/-S/-S-2/-SS/-SS-2; 94-P/-P-2/-PC/-PC-2; 103/-C/-C-2/-2; 190-B/-BT/-M/-MMR/-MS/-MST/-MT/-S/-SS/-SST/-ST; 191-P/-PT; 192-P/-PC/-PCT/-PT; 202/-C/-CT/-T	12722
95-M/-MS/-P; 96-P/-PC; 106/-C	46439
80-H/-HT/-M/-MT; 83-H/-H-2/-M/-M-2/-MS/-MS-2 180-MS/-MST	12022
85-H/-M/-MS	46448
104-H/H-2/-M/-M-2/-MS/-MS-2; 201-H/-M/-MS	13522
105-H/-M/-MS	46440
81-P/-PT; 82-P/-PC/-PCT/-PT; 83-P/-P-2; 84-P/-P-2/-PC/-PC-2	12035
86-P; 87-P/-PC	46449

PARTS TABLE III

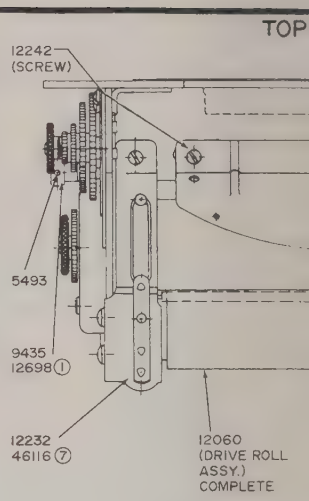
CHART DRIVE STYLE NUMBER	RIGHT SIDE PLATE ASSY.
93-B/-B-2/-M/-M-2/-MS/-MS-2/-P/-P-2/-S/-S-2/-SS/-SS-2; 94-P/-P-2/-PC/-PC-2; 95-M/-MS/-P; 96-P/-PC; 103/-C/-C-2/-2; 106/-C; 190-B/-BT/-M/-MMR/-MS/-MST/-MT/-S/-SS/-SST/-ST; 191-P/-PT; 192-P/-PC/-PCT/-PT; 202/-C/-CT/-T	12726
83-H/-H-2/-M/-M-2/-MS/-MS-2/-P/-P-2; 84-P/-P-2/-PC/-PC-2; 85-H/-M/-MS; 86-P; 87-P/-PC	21478
80-H/-HT/-M/-MT; 81-P/-PT; 82-P/-PC/-PCT/-PT; 180-MS/-MST	12026
104-H/-H-2/-M/-M-2/-MS/-MS-2; 105-H/-M/-MS; 201-H/-M/-MS	13526



LEFT SIDE VIEW



FRONT



TOP

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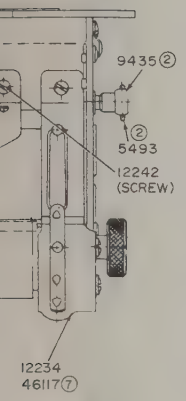
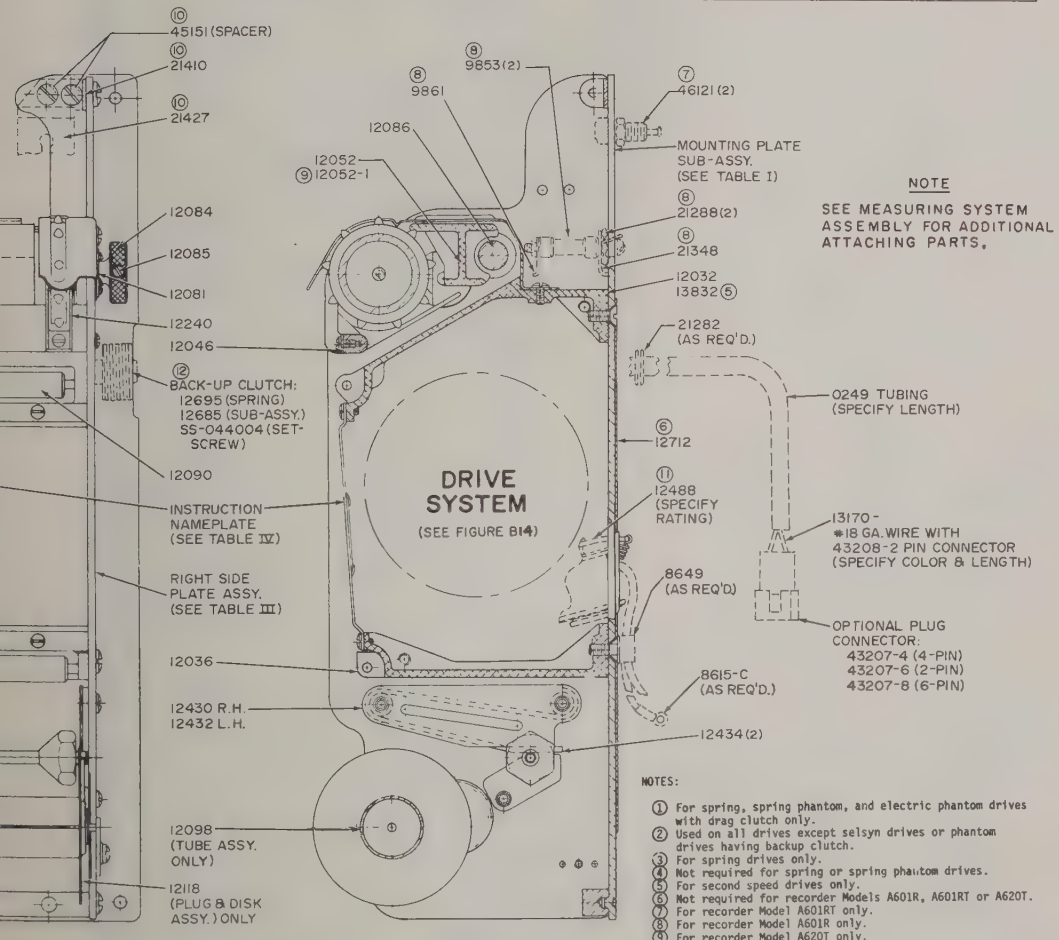
Figure B13. Chart

PARTS TABLE IV

CHART DRIVE STYLE NUMBER	PART DESCRIPTION AND NUMBER									
		DRIVE ROLL GEAR TRAIN			REROLL GEAR TRAIN					
	Instruction Nameplate	3rd Wheel Shaft Assembly	4th Wheel Assy.	Intermediate Plate Assy.	Complete Reroll Assy.	Reroll Top Plate	2nd Wheel Gear Assy.	3rd Wheel Gear Assy.	4th Wheel Assy.	Clutch Plate Sub-Assy.
93-M/-M-2/-MS/-MS-2; 95-M/-MS; 190-M/-MMR/ -MS/-MST/-MT	12040-B	12734	12744	12729	12758	12804	12760	12770	12775	12803
93-S/-S-2/-SS/-SS-2; 190-S/-SS/-SST/-ST	12040-B	13728*	13742**	13712	12758	12804	12760	12770	12775	12803
93-B/-B-2; 190-B/-BT	12043	13826	12199	13814	12758	12804	12760	12770	12775	12803
80-H/-HT/-M/-MT; 83-H/ -H-2/-M/-M-2/-MS/-MS-2; 85-H/-M/-MS; 180-MS/ -MST	12042	12134	12198	12031	12350	12356	Part of Drive System	12366	12378	12388
104-H/-H-2/-M/-M-2/ -MS/-MS-2; 105-H/-M/ -MS; 201-H/-M/-MS	12038	Part of Drive System	12198	13531	13507	12804	12760	12770	12775	13503
81-P/-PT;82-P/-PC/-PCT/ -PT;83-P/-P-2;84-P/-P-2/ -PC/-PC-2;86-P;87-P/-PC	12043	12135	12199	12029	12350	12356	Part of Drive System	12366	12378	12388
93-P/-P-2; 94-P/-P-2/ -PC/-PC-2; 95-P; 96-P/ -PC; 191-P/-PT; 192-P/ -PC/-PCT/-PT	12040-B	12135	12199	12729	12758	12803	12760	12770	12775	12803
103/-2; 106; 202/-T	12043	13658	12199	13664	12758	12804	12760	12770	12775	12803
103-C/-C-2; 106-C; 202-C/-CT	12043	13668	12199	13664	12758	12804	12760	12770	12775	12803

NOTES: *Also requires 3rd Wheel Quill Assy. No. 13734. **Also requires 4th Wheel Quill Assy. No. 13740.





RIGHT SIDE CROSS SECTION

NOTE

SEE MEASURING SYSTEM ASSEMBLY FOR ADDITIONAL ATTACHING PARTS.

NOTES:

① For spring, spring phantom, and electric phantom drives with drag clutch only.
② Used on all drives except selsyn drives or phantom drives having backup clutch.
③ For spring drives only.
④ Not required for spring or spring phantom drives.
⑤ For second speed drives only.
⑥ Not required for recorder Models A601R, A601RT or A620T.
⑦ For recorder Model A601RT only.
⑧ For recorder Model A601R only.
⑨ For recorder Model A620T only.
⑩ For recorder Model A601R with cartridge (Type 2) inking system only.
⑪ For spring and motor-wound spring drives with electric shift only. If series resistor is required, specify value.
⑫ For phantom drives as required. External drive may be reversed without reversing chart.
⑬ For motor-wound spring drives only.

s Location Diagram

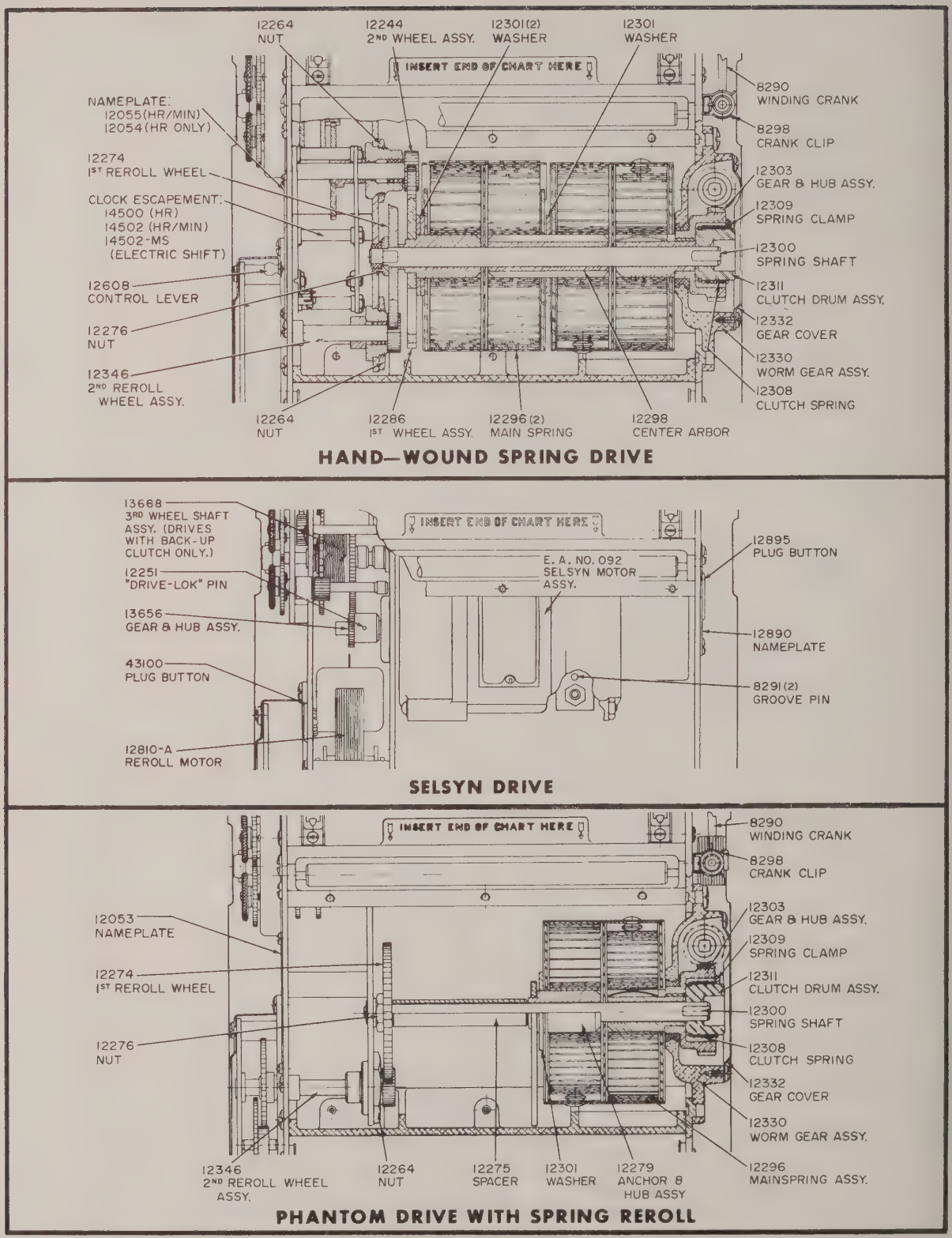


Figure B14A. Drive Systems Diagrams

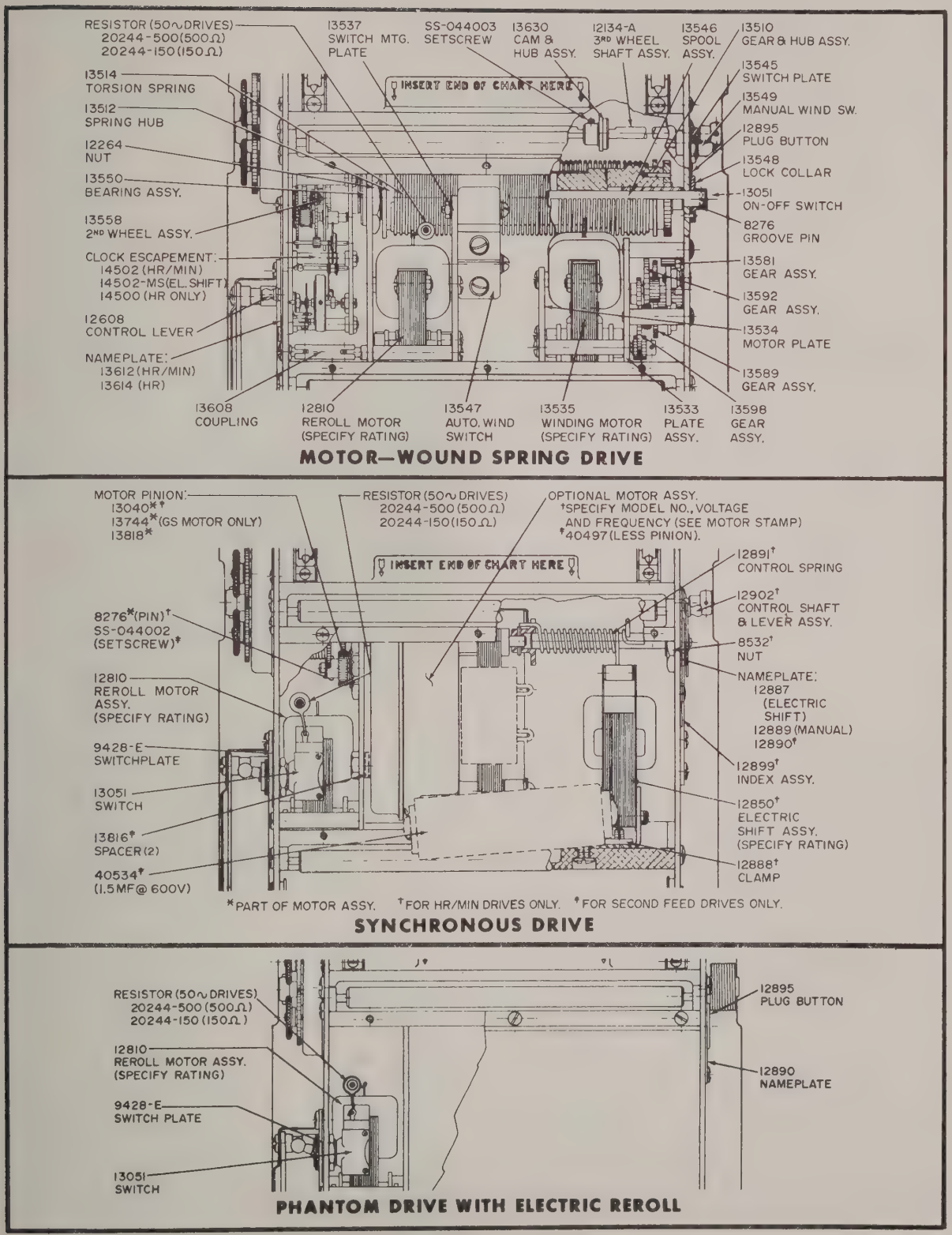


Figure B14A. Drive Systems Diagrams

PART C

MEASURING AND RECORDING SYSTEM

SECTION 1 - INTRODUCTION

1.1 GENERAL

a. This part of the manual includes descriptive data, operating procedures, and maintenance instructions for the recording elements employed in Esterline Angus Multi-channel Event Recorders, Models A620X and A620T. When information in this part of the manual pertains to a specific model only, the model number will be clearly specified. Refer to the Data Sheet supplied with this manual for information concerning your specific instrument.

> NOTE: When applicable, production change notices and supplemental information on special instrument modifications or optional equipment will be found in the APPENDIX, PART D of this manual.

b. The Model A620X and Model A620T recorders are designed to graphically record "on-off" or "yes-no" event information on a 6" strip-chart with rectilinear coordinates. Standard instruments are available with 5, 10 or 20 active channels (up to 40 channels in twin recorders). The only basic differences existing between the two models are: Model A620X employs inking pens which record on standard chart paper; whereas, Model A620T has electrically-heated styluses and uses a special, sensitized chart to record events.

> CAUTION: If ambient temperatures exceed 100°F, chart drives with hand-wound or motor-wound springs should not be used in the Model A620T (heat writer) recorder.

c. Electromagnets are used to deflect the writing element of each recording channel and are available for recording input ratings from 2 to 250 volts, AC or DC. Although the electromagnets are designed to operate on voltages 15% above or below rated voltage, best results are obtained by keeping the operating voltage as near to the rated value as possible. Voltages outside the rated requirements of the electromagnet circuits can be used, however, through the addition of a series resistance, current shunt, or step-down transformer.

A high impedance adapter is also available for DC instruments to record events in low-power circuits.

1.2 SPECIFICATIONS

Tables C1 and C2 reflect general specifications for the recording system employed in Esterline Angus Event Recorders. Refer to the Data Sheet for specific information describing your particular instrument.

1.3 DESCRIPTION

1.3.1 Recording Method

Each writing element in the recorder responds to channel input through the actuation of an individual electromagnet which is mechanically engaged with the element (Figure C1). When the electromagnet is energized, it causes the writing element to deflect 1/10 inch laterally to the "on" or "yes" position. The element remains in the deflected position until the electromagnet is de-energized; then returns to the "off" or "no" position. Full deflection can still occur with a voltage pulse lasting only 15 milliseconds. The writing element can follow pulses up to 10 cycles per second when the "on" and "off" durations are approximately equal.

1.3.2 Circuit Configurations

a. Three basic types of recording circuits are offered in the standard Esterline Angus Event Recorder series. Each type employs a different method of wiring the input signal to the electromagnet of each recording channel. Refer to the Data Sheet and to the nameplate located on the inside (bottom) of the instrument case for the type employed in your re-

TABLE C1
EVENT RECORDER CHARACTERISTICS

Instrument Type - Multi-Channel Rectilinear Event.
Circuit Configurations (Optional) - - - - - - - - - Isolated, Common-Return, or Switch Type.
Input Ratings (Optional) - Refer to Table C2.
Number of Channels:
  Model A620X Ink Writer - 5, 10, 15 or 20 (Optional).
  Model A620T Heat Writer - 10 or 20 (Optional).
Channel Designations - Ruled Chart and Numbered Scaleplate.
Actuation - AC or DC Electromagnets (±15% of Rating).
Element Displacement - 0.1 INCH (Minimum).
Response:
  Pulse Width ("ON" or "OFF") - - - - - - - 15 Milliseconds (Minimum) for full deflection.
  Repetition Rate (Maximum) - - - - - - 10 cycles per sec. with equal ON and OFF periods.
Recording Method:
  Model A620X Ink Writer - - - - - - - - - - - - - - - Pen and Ink (with 1.25 oz. ink supply).
  Model A620X Heat Writer - - - - - - - - - - - - - - - - - - - Electrically Heated Styluses.
Strip Chart:
  Mod. A620X Ink Writer - - - - - - - 20 (0.3") Channels, 6" Total Width, 103' length, with Ink Receptive Surface and Optional Time Markings.
  Mod. A620T Heat Writer - - - 20 (0.3") Channels, 6" Total Width, 81' length, with Heat- and Pressure-Sensitive Surface and Optional Time Markings.
Dielectric Test - 1,500V, 60Hz for One Minute.
Connection Provisions - - - - - Screw-Type Rear Terminals. "Switch-Type" leads may have up to 35Ω/Ckt. (Approx. 5,000' of #18 wire; 2,500' one way) .
Adjustments (Mod. A620T only) - - - - - - - - - - - - - On-Off Heat Switch, Heat Control and Stylus Pressure Adjust.
Power Requirements* (Mod. A620T only) - - - - - - - - 120 or 240V, 50/60Hz. (Heat Circuit).
Other Options - - - - - - - - - - - Step-down transformer for "Switch-Type" operation; High-Impedance Adapter; Totaling Counters; 12V DC Heat Circuit for Mod. A620T.

* Refer to other parts of this manual for chart-drive and lighting power requirements.

TABLE C2. ELECTROMAGNET CIRCUITS.

Electromagnet Voltage Rating	Coil Style	Nominal Current (MA)	DC Resistance (ohms±15%)	Power Consumption (Watts)
Direct Current				
2V	N	570	3.5	1.1
4V	K	286	14	1.1
6V	J	231	26	1.4
8V	G	131	61	1.0
10V	F	99	101	1.0
12V	F	119	101	1.4
14V	E	90	156	1.3
16V	D	67	238	1.1
18V	D	76	238	1.4
24V	C	65	372	1.6
28V	B	42	666	1.2
32V	A	29	1092	0.9
48V	T	29	1650	1.4
125V	T	31	1650①	3.9
250V	T	26	1650②	6.5
50-60 cps AC				
6V	N	447	3.5	1.6
12V	K	233	14	1.7
24V	G	103	61	1.5
120V④	G	103	61	1.5
120V	T	20	1650	1.5
240V④	G	103	61	1.5
240V	T	21	1650③	4.5

①Requires 2400-ohm series resistance. ③Requires 7000-ohm series resistance.
②Requires 8000-ohm series resistance. ④Used with internal step-down transformer for 24V switch-type operation.

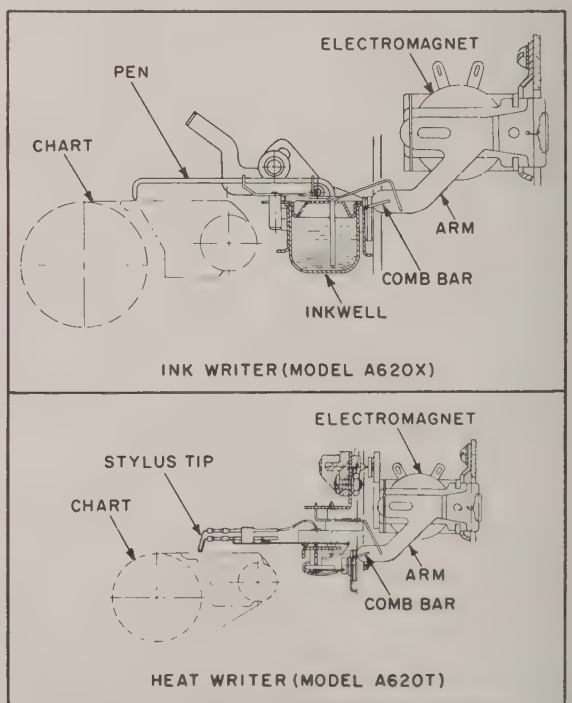


Figure C1. Event Recorder Writing Elements.

corder. The following paragraphs describe the three types of recording circuits and discuss their usage. (See Figure C2.)

b. COMMON RETURN CIRCUIT: In the voltage-type, common-return configuration, one side of every electromagnet coil is connected to a common lead which may be terminated at one or more connection points on the rear of the instrument case. The other side of each coil is terminated at individual connections, which are externally connected to individual impulse sources. This type of instrument will frequently be used in the study of timing cycles for a number of automatically controlled processes.

c. SEPARATE CIRCUITS: In the voltage-type, separate-return configuration, each side of every electromagnet coil is terminated at an individual connection point on the rear of the recorder. This isolated type of circuit is used where the wiring of the electromagnets must not be interconnected. The use of this type of recorder will often eliminate the need for determining polarities and simplifies installation.

d. SWITCH-TYPE CIRCUIT: This configuration utilizes external switches and an internal power source to energize the electromagnets. There is no voltage existing in the external event circuits. An internal step-down transformer has a secondary which supplies approximately 24-volts AC to actuate the electromagnets. One secondary lead of this transformer is connected to one side of every electromagnet coil within the instrument, while the other secondary lead is connected in series with the external switches to the other side of each coil. The primary of the internal transformer is powered from an external source of either 120 or 240 volts, 50 or 60Hz.

1.3.3 Recording Media

a. INK WRITER (MODEL A620X): In the ink writer model, the writing element for each channel includes a pen which records a permanent, continuous ink pattern on the moving, ink-receptive chart paper during recording operations. All pens employed in the instrument are fed from a common enclosed ink reservoir (which also mechanically supports and aligns the pens). The complete inkwell/pen assembly can be easily removed from the recorder for maintenance purposes.

b. HEAT WRITER (MODEL A620T): In the heat-writer model, electrically-heated styluses are used to produce permanent, continuous records on non-waxed, heat- and pressure-sensitized chart paper. An independent, internal power supply is provided with these instruments to heat the styluses. The stylus-heat circuit can be rated for operation on 120, 240 volts, 50- or 60-Hz, or from a special 12V DC source. A rheostat in series with the circuit allows adjustment of stylus temperature to control recorded line density. Removal of the stylus-mount assembly is covered under MAINTENANCE in this part of the manual.

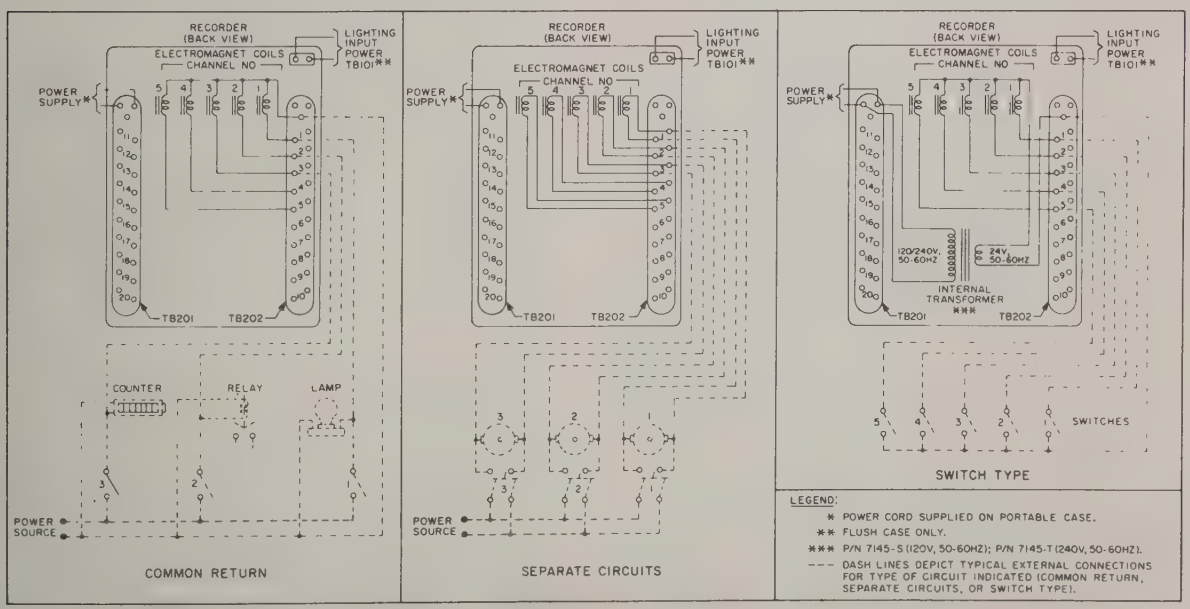


Figure C2. Standard Event Recorder Circuits.

1.4 GENERAL APPLICATIONS

a. Any phenomenon known to science that can be represented by an "off-on" condition may be graphically recorded on the Model A620X or Model A620T. Events are recorded by opening or closing external circuitry connected to the channel inputs of the recorder. The operation to be studied may, however, be mechanical or physiological in nature rather than electrical; in this case, switches or connectors of some sort must be used to convert the phenomenon into electrical impulses.

b. Various switches, relays, and contact making devices are commercially available for application with physical movement. Some of these are cam types, centrifugal types, extended lever types, and brush or finger types. Where physical contact with an object is impossible, photo-electric relays may be used as event counters. Since a photo-cell circuit can be made to respond to the presence or absence of light, it may be used to indicate the presence of a flame, a glowing object, or the on-off condition of any light source. Switches are available that will close electrical contacts when desired pressure or vacuum exists. Thermostats, timers, float switches, and many other devices are available to convert a phenomenon stimulus into electrical impulses. The impulses are then applied to the event recorder and an intelligible record is obtained.

c. Methods of actuating the electromagnets will depend upon the type of instrument selected. Where the condition or phenomenon to be recorded is mechanical rather than electrical, switches or connectors may be used to interrupt an external voltage source, and thus convert the condition to electrical impulses. The contact-making device may be operated from mechanical rotation or thrust, from changing position, or from changes in pressure, temperature, light intensity, etc. In certain applications when an external switch is open, a potential may still remain on the lead connected to the electromagnet. Such a safety hazard can usually be avoided by employing a recorder with the separate-return circuit configuration.

d. The switch-type instrument is used where the recorded event mechanically actuates a switch or connector. Some applications of the switch-type instrument are the recording of movements, the productive and idle time of machinery, the passage of objects on a conveyor, the flow of liquid, and the revolution of a shaft.

e. Either the switch-type or voltage-type of recorder may be used where switches, contacts, or relays operate the electromagnets and where the source is AC. The use of the switch type, however, permits lower operating voltages which makes possible a reduction in wiring costs, and also eliminates the hazards of high voltages. The voltage-type recorder must be used when only DC voltage is available.

f. There are some applications where the applied voltage may vary over too wide a range for satisfactory operation of a voltage type of recorder, or where currents are too large to be brought directly to the instrument. In such instances, appropriate relays should be connected into the circuits to provide the necessary on-off impulses.

g. In all event recorder applications, it is essential that the instrument respond only when the desired action takes place. This may involve the fulfilling of two or more conditions simultaneously. In such cases, two or more switches may be used in series; the electromagnet being energized only when both switches are closed.

h. In other applications it may be desirable to total the number of events for a certain period of time. This function may be achieved automatically by connecting a counter in parallel with each electromagnet of a voltage-type recorder. An alternate method would be to connect a self-starting synchronous clock in place of the counter; the clock will run only when the electromagnet is energized, and will thus totalize the number of events.

SECTION 2 - OPERATION

2.1 GENERAL

a. Do not attempt to put this instrument into operation until all instructions have been thoroughly studied. Failure to make proper connections or to make necessary checks and adjustments may result in unsatisfactory operation or damage to the instrument.

b. To prepare the recording system for operation, all packing materials must be removed, proper electrical connections made, adjustments performed, and, in ink writers--the inking system filled and primed. Instructions for installing chart paper and operating the chart drive are included in PART B of this manual. When applicable, supplemental infor-

mation for special instrument modifications or optional equipment will be provided in the APPENDIX (PART D) of this manual.

2.2 EXTERNAL CONNECTIONS

2.2.1 Power Input

External power input connections for electric chart drives, stylus-heat circuits and for most recorder accessories are made to terminals located on the rear of the instrument case. Portable recorders, however, are equipped with a power cord when an electric drive is supplied. Typical connections for power input are shown in Figure C2.

> CAUTION: Always check operating voltage ratings on the Data Sheet or on the nameplate located on the inside (bottom) of the recorder case before making connections to the instrument.

2.2.2 Event Signal Input

a. External signal input connections for the event channels are made to terminals located on the rear of the recorder case. Typical connection diagrams are shown in Figure C2. All terminals are marked with an identifying number which corresponds to a channel number. Electrical data for the recorder is located on a nameplate inside the case (on the bottom) and on the Data Sheet.

> CAUTION: Always check polarity and recording circuit input ratings before making connections. A series resistance or step-down transformer may be required.

b. In permanent installations where the writing element electromagnets are to operate on DC, the electromagnet coils should be connected to the negative polarity of the power supply; the switches or relay contacts which actuate the electromagnets should be connected to the positive polarity between the power supply and the electromagnets.

c. Leads used with switch-type recorders can be approximately 5,000 feet of No. 18 wire (2,500 feet one way). Total resistance should not exceed 35 ohms per circuit.

> CAUTION: For the switch-type recorder, there must be no voltage present in the external circuits connected to the electromagnet terminals.

2.3 INKING INSTRUCTIONS (MODEL A620X ONLY)

2.3.1 Preparations for Inking

a. Esterline Angus ink is employed in the ink-writer event recorder to produce a permanent record on the chart paper. This writing fluid is especially formulated to satisfy the exacting requirements of recording instruments; therefore, no substitute should be used.

> NOTE: Keep the ink bottle tightly capped to minimize evaporation and avoid contamination of the ink supply.

b. The recorder is shipped with the inking system in a dry state. As part of putting the instrument in operating condition, the pens must be freed by untying the string that secures them to the scaleplate, the cardboard must be removed from above the pens, the inkwell must be filled with ink and the system primed in accordance with the instructions in paragraph 2.3.2.

> NOTE: Ink may begin to crystalize at low temperatures; therefore, heat must be provided within the instrument if the temperature is expected to remain below 20°F.

c. Prior to making the inking system operational, a new chart should be installed by following steps given in the charting instructions (Part B); also, see that all shipping materials have been removed from the instrument.

d. Unpack the accessory kit supplied with the recorder. This kit should include the following items:

1 - Two-ounce bottle of ink
1 - Inkwell filler syringe
1 - Pen-filler syringe
1 - Pen-point cleaner

> NOTE: Two accessory kits are supplied with each twin-case instrument. Replacement kits are available under Part No. 5785-(specify ink color).

2.3.2 Inking Procedures

a. FILLING THE INKWELL: To fill the inkwell, proceed with the following steps:

(1) Open case door or remove front cover.

(2) Turn off chart drive and de-energize recording system.

(3) Swing scaleplate upward to gain access to inkwell area.

(4) Remove pens from channels 12 and 13 that cover the inkwell filler hole (Fig-C3).

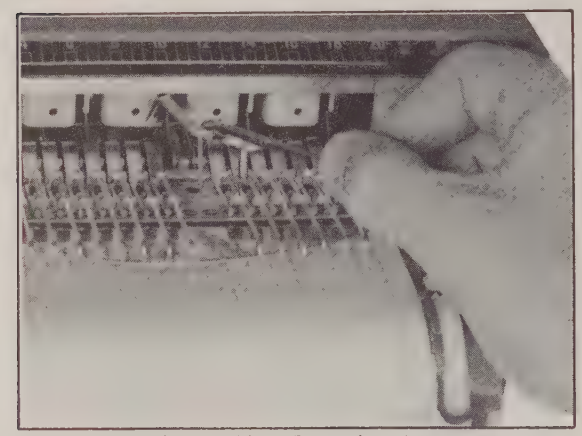


Figure C3. Removing Pens.

(5) Using syringe supplied, fill inkwell slightly over half full of Esterline Angus ink as shown in Figure C4.

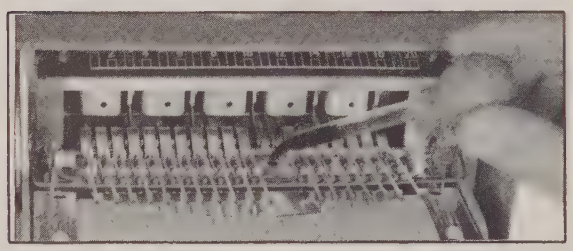


Figure C4. Filling the Inkwell.

(6) Replace pens removed in Step 4.

NOTE: Make sure pen tails engage flat, finger-like lever arms extending from each electromagnet (Figure C5).

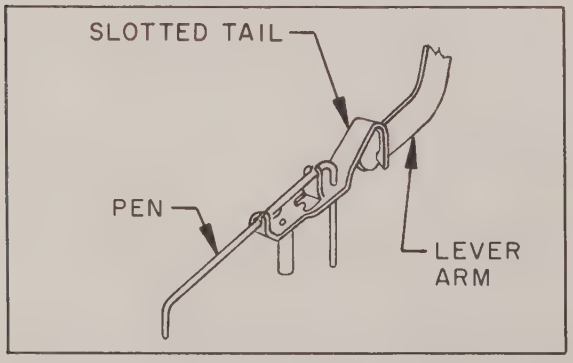


Figure C5. Engage Pen Tail with Lever Arm.

b. PRIMING THE PENS: To prime the system, proceed as follows:

(1) Compress pen-filler bulb and insert pen point into small hole provided in rubber tip of filler-syringe, as pictured in Figure C6.

(2) Release bulb slowly until ink appears in glass tube of syringe.

NOTE: When priming, avoid extracting an excessive quantity of ink from the inkwell.

(3) Repeat Steps 1 and 2 for the pens of each active channel.

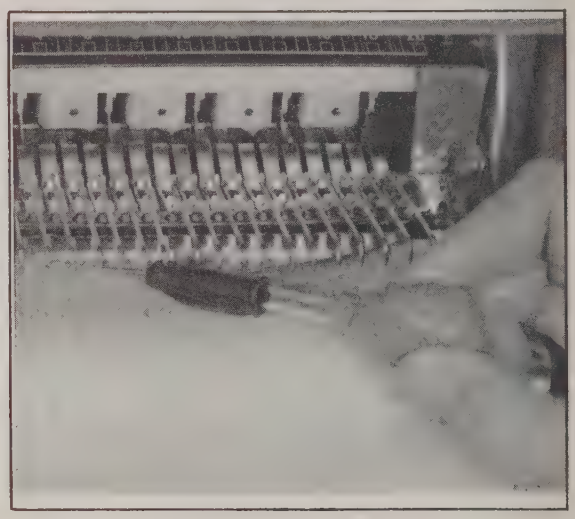


Figure C6. Priming the Pens.

c. After priming the pens, return the scale-plate to its normal viewing position. Make sure that the pen points are all resting on the chart paper. Turn on the chart drive, connect the input signals and check for proper recording. (Refer to Part B of this manual for chart drive operation.)

CAUTION: Always remove the inkwell/pen assembly before subjecting the instrument to handling that may spill ink. If ink is spilled on the recorder, remove immediately with a damp cloth or paper towel.

d. Wash the accessory syringes with clear water after each use. If ink is spilled on clothing, the spots should be washed as soon as possible, preferably with warm water and Lava soap. Persistent washing will usually remove such spots. Refer to the MAINTENANCE instructions in Section 3 for additional care of the inking system.

2.4 STYLUS OPERATION (MODEL A620T ONLY)

The internal stylus-heat circuit of the heat-writer event recorder is designed to provide graphic records without smoke, fumes or odor. To heat the styluses, turn on the stylus heat switch located on the top of portable, wall, and front-switchboard cases; or, to the right of the scaleplate inside flush-mounted cases. (Refer to paragraph 2.5.2a for stylus-heat adjustment).

> CAUTION: To prevent the stylus tips from sticking to the chart paper, always turn on the stylus heat switch 5 seconds before starting the chart drive, and turn off the switch 30 seconds before stopping the chart drive.

2.5 ADJUSTMENTS

All multi-channel Event Recorders are carefully adjusted and properly tested before leaving the factory; however, the following field adjustments may be required to satisfy various applications.

> NOTE: Refer to the Appendix, Part D for additional adjustment procedures when special modifications or optional equipment is supplied.

2.5.1 Ink Writer (Model A620X)

a. PEN PRESSURE ADJUSTMENT: When the pens are placed into operation for the first time, they may not rest on the chart until the inkwell pen assembly is completely filled with ink. The pens supplied with the recorder have been properly balanced so that when the inkwell/pen assembly is filled with ink (and the pens primed), each pen will record on the chart paper with the proper point pressure.

b. Excessive pen pressure may cause recorder response to appear sluggish, while insufficient pen pressure may cause skips in the recorded pattern. If, for any reason, it becomes necessary to adjust pen pressure, the pen point(s) can be bent slightly using duckbilled pliers. If necessary, a pen element can be individually removed and replaced (refer to DISASSEMBLY instructions in Section 3 of this part of the manual).

c. CHANNEL REFERENCE ALIGNMENT: Each pen element must be checked periodically to insure accurate recording. If the chart drive has been repaired or moved from one instrument to another, adjustment may be required to make the pens write on their respective lines. Before attempting this adjustment, however, make certain that no signals are applied to the input terminals and that the pens are full of ink and are properly installed.

d. If the entire complement of pens is displaced too far to the right or left, adjustment of the comb bar (located behind the inkwell/pen assembly) will be necessary. To adjust the comb bar, first remove the inkwell/pen assembly as directed in Section 3 of this part of the manual under DISASSEMBLY.

e. The comb bar can now be adjusted by loosening the two hex-head studs which pass through the bridge spacer-supports at each end of the inkwell area (located behind the top of the chart drive). Pry the comb bar to the right or left as required to correct the misalignment of the pens. Tighten the studs, replace the inkwell/pen assembly (as directed in Section 3). Apply the input signals and check recording alignment. Repeat the adjustment as necessary until proper alignment is achieved.

f. If an individual pen element is displaced too far to the right or left of the proper reference line, the pen point can be bent slightly using duckbilled pliers, or the pen element can be removed and replaced as directed in Section 3.

2.5.2 Heat Writer (Model A620T)

a. STYLUS HEAT ADJUSTMENT: The temperature of the styluses in a heat-writer event recorder governs the density of the trace. A rheostat connected in series with the stylus-heat circuit permits the operator to vary this temperature. The heat adjustment is accessible from the front of the instrument (with cover off or door open). This control has a slotted shaft that projects through a hole in the lower-right side of the chart-drive mounting plate; and it is adjustable with a screwdriver as shown in Figure C7.

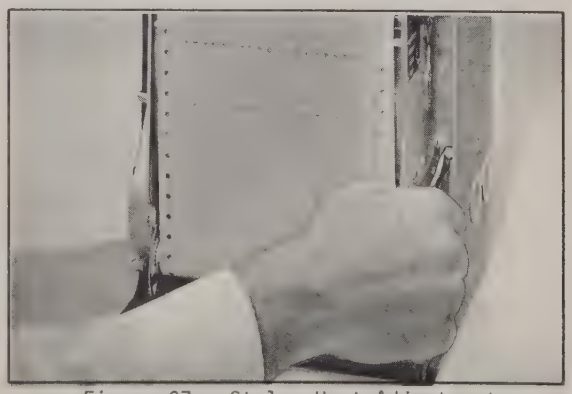


Figure C7. Stylus-Heat Adjustment.

b. To obtain a lighter trace line, reduce stylus temperature by rotating the heat control counterclockwise. The recorded line will become darker when the control is rotated clockwise. It is recommended that this control remain in an advanced clockwise position for optimum line perception.

c. STYLUS-PRESSURE ADJUSTMENT: Pressure of the styluses on the sensitive chart paper is a factor that determines recorded-line width. If pressure is too light, the styluses will produce wide, blurry lines. If pressure is too heavy, the styluses will tend to drag and may not achieve a complete lateral response when the electromagnets are energized.

d. The pivoted spring tension of the stylus mounting assembly permits the operator to adjust stylus pressure. A 3/8" hex nut, located slightly above and behind the scaleplate, is provided to adjust the entire complement of styluses. Refer to Figure C8.

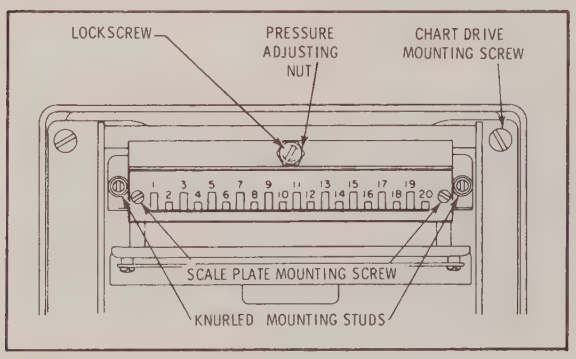


Figure C8. Stylus-Pressure Adjustment.

e. To make the adjustment, first turn the stylus-heat control fully counterclockwise, then loosen the lockscrew in the center of the stylus-pressure adjustment nut (Figure C8). Adjust the nut so that all styluses are producing fine lines on the chart paper and are properly recording all lateral movement. Advance the heat control 1/4 turn clockwise if the lines are not visible.

f. When desired pressure is obtained, tighten the lockscrew to hold the stylus-pressure adjustment nut in position; advance the stylus-heat adjustment screw (clockwise rotation) for a darker trace; and check operation. If individual lateral lines appear to run together at slow chart speeds, increase the speed or reduce stylus temperature.

> WARNING: Avoid direct contact with the heated stylus tips when making adjustments.

g. If pressure adjustment is required on an individual stylus, turn the stylus heat switch off and allow the tips to cool; then, carefully bend the stylus tip with duckbilled pliers until proper pressure is obtained.

h. CHANNEL REFERENCE ALIGNMENT: Normally, the styluses will record on their respective channel reference lines; however, if the entire complement of styluses is displaced too far to the right or left, the comb bar, which is used to limit the swing of the electromagnet levers, should be adjusted.

i. To gain access to the comb bar area, remove the stylus-mount assembly from the instrument (Refer to Section 3, under DISASSEMBLY, in this part of the manual). To adjust the comb bar, loosen the mounting screws at each end of the comb bar and pry the bar slightly to the right or left as required. Tighten the comb bar mounting screws, replace the stylus-mount assembly, and check operation. Repeat the procedure as necessary until proper alignment is achieved.

j. If only certain styluses fail to record on their respective channel-reference lines, turn off the stylus heat-switch, allow the tips to cool, and carefully bend the end of each displaced stylus with duckbilled pliers until properly aligned.

SECTION 3 - MAINTENANCE

3.1 GENERAL

a. The components employed in the recording system of the event recorders are designed and rated for long, trouble-free operation. Nevertheless, they should receive the care afforded any precision piece of equipment to extend their useful life.

b. If minor problems should occur in the field, refer to the maintenance procedures that follow. Refer to PART B of this manual for chart drive maintenance procedures, to Section 2 in this part of the manual for adjustments, and to the APPENDIX, (PART D) for special instructions on optional systems. In the few cases where major repairs are necessary, con-

tact your local Esterline Angus representative for instructions.

3.2 ROUTINE MAINTENANCE

> WARNING: To prevent accidental shock, always remove power from the instrument before disassembling or servicing.

Except for replacing chart paper (and adding ink in ink-writers), the instrument should require little attention. Periodic maintenance schedules should, however, be established which include inspection, cleaning, and adjustment of the recording system.

3.2.1 Inspection

a. A visual inspection of the recording system components should be made at each maintenance period with particular attention to the following:

(1) Chart (and ink) supplies.

(2) Accumulation of dirt or other foreign material within the instrument.

(3) Leaky or clogged inking system (Model A620X only).

(4) Worn or bent writing elements.

(5) Writing element misalignment.

(6) Damaged wiring, loose connections, and burnt electrical components.

b. If any of the above items are evident, corrective measures should be taken without delay.

3.2.2 Cleaning

a. The recorder case and external surfaces of certain recording system components (such as terminal blocks and scaleplate) may be cleaned with a dampened cloth and wiped dry with a lint-free cloth.

> NOTE: See "Care of Inking System" for pen and inkwell cleaning procedures.

b. The chart drive must be removed from the instrument case to gain access to internal components. A low-pressure vacuum or non-metallic, soft-bristled brush may be used to clean all electrical parts.

> CAUTION: Do not disturb parts or wire routing during cleaning procedures.

3.2.3 Care of Inking System (Model A620X only)

a. To achieve proper inking, the ink supply and pen elements must be inspected regularly. Fresh ink should be added whenever needed, and the pen points kept free from dirt, lint, and dried ink at all times.

b. CLOGGED PENS: If recording is conducted at relatively fast chart speeds, ink will flow rapidly and there will be little chance of the system clogging. However, if the recorder has idle periods or runs at a slow chart speed, clogging may occur.

c. The pens can normally be unclogged by drawing ink through the system. Insert each pen point into the rubber tip of the primer syringe, and prime the pen until several drops of ink come from the point; blot the tip and check operation. This routine procedure should remove any paper fiber or dirt that has accumulated in the pen points. If the system remains clogged, however, cleaning may be necessary.

d. CLEANING METHODS: Once a month, the inking components should be emptied, washed, and refilled with fresh ink. More frequent intervals for cleaning may be necessary and will depend upon environmental conditions and the nature of instrument operation. Skips in the recorded pattern or a tendency of the ink to spread on the chart paper are often indications that the system should be cleaned.

e. Two methods of cleaning the inking system are possible; the choice of method is left up to the user. A flushing method is practical when temporary clogging occurs; however, a complete disassembly and thorough washing of the inking system is recomended if the instrument has remained idle for a long period of time.

f. The flushing method of cleaning the inking system is recommended for minor clogging conditions. The pens and inkwell can be washed in one operation as follows:

(1) Turn off chart drive, and de-energize recording system.

(2) Remove inkwell/pen assembly as directed in paragraph 3.3.

(3) Remove pen element from one end of inkwell.

(4) Hold rest of pens in position, and pour out remaining ink through end hole.

(5) Replace end pen, and remove pens covering ink-filler hole near center of inkwell cover (channels 12 and 13).

(6) Direct stream of water into filler hole of inkwell. (Water will be forced through pen elements.)

(7) Continue operation until water coming from pens is clear. If water will not pass through any badly clogged pens, open pen with cleaning wire (refer to para. h).

(8) Flush pens removed from filler-hole area.

(9) Remove end pen from inkwell and pour out water; replace pen.

(10) Remove water from pens by laying inkwell/pen assembly so that pen tips rest on absorbent towel or blotter for approximately ten minutes. Dry excess water from all areas of assembly.

(11) Fill inkwell with ink, replace fill area pens, install assembly in recorder, and prime pens.

NOTE: When installing assembly, make sure that inkwell seats all the way down in its holder at both ends.

(12) Turn on chart drive, energize recording system, and check operation.

g. The second method of cleaning the inking system involves disassembling the inkwell/pen assembly; however, this method is only necessary if the recorder has been idle for a length of time and ink has dried in the inkwell and pen elements. To thoroughly clean the inking system, proceed with the following steps:

(1) Turn off chart drive, and de-energize recording system.

(2) Remove inkwell/pen assembly as directed in paragraph 3.3.

(3) Remove all pen elements from inkwell, and pry off inkwell cover.

CAUTION: Do not bend or damage cover.

(4) Thoroughly wash inkwell and remove all dried ink.

(5) Force water through pen elements with rubber filler syringe. If absolutely necessary, use cleaning wire to open pens (refer to para. h).

(6) Drain water from pens with blotter or absorbent towel, and dry excess water from all areas of inkwell and elements.

(7) Align small impressions on sides of cover with those on sides of inkwell, then replace cover on inkwell by pressing firmly in place.

NOTE: Covers are designed for specific inkwells -- do not interchange.

(8) Fill inkwell with ink through filler hole, and replace pen elements.

(9) Install inkwell/pen assembly in recorder, and prime pens.

NOTE: When installing assembly, make sure that inkwell seats all the way down in its holder at both ends.

(10) Turn on chart drive, energize recording system, and check operation.

h. CLEANING WIRE: The cleaning wire, which is supplied in the Model A620X accessory kit, should not be used to clear clogged pens unless absolutely necessary. If the wire is used, carefully work it straight in and out of the pen. Keep the wire centered in the pen and avoid scrapping the sides of the orifice. If the pen tip becomes damaged, it will be necessary to replace the entire pen element.

i. If ink has been spilled on the recorder, remove immediately with a damp cloth or paper towel. Spots on clothing should be washed as soon as possible, preferably with warm water and Lava soap. Persistent washing will usually remove such spots. Wash all accessory syringes with clear water after each use.

3.3 DISASSEMBLY (INK WRITER, MODEL A620X)

3.3.1 Inkwell/Pen Assembly Removal

a. The inkwell/pen assembly of the ink writing event recorder is designed to allow any pen element requiring attention to be removed and replaced individually. It is recommended, however, that the complete inkwell/pen assembly be removed from the instrument before attempting to remove an individual pen element.

CAUTION: Turn off the chart drive and de-energize the recording system prior to disassembly.

b. To remove the inkwell/pen assembly, swing the scaleplate upward to gain access to the inkwell area. Press down on the metal levers at each end of the inkwell and,when it springs

free, carefully lift the assembly up and out of the instrument as illustrated in Figure C9.

Figure C9. Inkwell/Pen Assembly Removal.

3.3.2 Individual Pen Element Removal

Once the inkwell/pen assembly has been removed from the recorder, individual pens can be easily removed from the assembly by carefully lifting them straight up from the inkwell cover. Pen replacement can be accomplished by lowering the pen element feed tube into the small hole in the inkwell cover and guiding the element counterweight into the larger hole located forward of the pen tube hole.

3.3.3 Inkwell/Pen Assembly Replacement

NOTE: Check the position of the pen-lifter wire to be sure it is down as far as it will go with the scaleplate all the way back. The inkwell/pen assembly must pass over this wire during replacement.

a. To replace the inkwell/pen assembly in the recorder, carefully position the assembly in the instrument so that the flat tension springs at each end of the inkwell are resting between the bridge spacers at each side of the inkwell area.

b. To seat the inkwell/pen assembly, press down on both ends of the inkwell with equal pressure until the springs snap in place between the bridge spacers. Observe the position of each pen element to be sure the pen tails have properly engaged the flat, finger-like lever arms extending from each electromagnet. Return the scaleplate to its normal viewing position, turn on the chart drive, energize the recording system, and resume operation.

3.4 DISASSEMBLY (HEAT WRITER, MODEL A620T)

3.4.1 Stylus-Mount Assembly Removal

a. The recording stylus-mount assembly of the heat-writing event recorder can be removed from the instrument for replacement, repair, or for adjustment of the comb bar.

WARNING: Prior to disassembly, place the stylus heat switch in the "off" position 30 seconds before turning off the chart drive. Disconnect instrument power.

b. To remove the stylus-mount assembly from the instrument, proceed with the following steps:

(1) Loosen lockscrew located in center of stylus-pressure adjustment nut (Figure C8), and remove nut.

NOTE: If desired, the scaleplate may be removed by removing two mounting screws from the face of the plate.

(2) Unscrew knurled mounting studs at each end of assembly (do not attempt to remove studs).

(3) Tip assembly slightly forward and lift out of instrument.

3.4.2 Stylus-Mount Assembly Replacement

To replace the assembly, reverse the removal procedures. After replacing the assembly, make sure that all styluses are straight so they will properly engage the electromagnet lever arms.

3.4.3 Individual Stylus Element Removal

Replacement or repair of an individual writing element involves a major disassembly procedure, and therefore, is not recommended as a field activity. If an individual writing element or stylus becomes damaged, contact the nearest Esterline Angus field representative for instructions. If the instrument must be returned to the factory for repairs, send for shipping instructions, and pack the recorder in accordance with PACKING FOR SHIPMENT information provided in PART A of this manual.

3.5 TROUBLESHOOTING

a. The simplified troubleshooting guides presented in Table C3 (for ink writers) and Table C4 (for heat writers) can be used to correct most minor recording problems that may occur in the field. The guide describes the most common troubles, lists the most frequent causes, and suggests the most likely remedy procedures. Refer to PART B of this manual for troubleshooting instructions dealing with the chart drive system of the recorder.

b. If trouble is indicated in the electrical circuits(s), the most logical troubleshooting approach is to isolate the fault to one electrical module or component -- such as a transformer, electromagnet or resistor. Voltage measurements, continuity checks, and DC resistance measurements may be necessary to pinpoint the trouble. Refer to the appropriate schematic in this manual.

CAUTION: Always remove power from the instrument before making DC continuity checks or resistance measurements.

c. If trouble is traced to a defective electromagnet, apply the appropriate voltage (see Data Sheet) to the leads of the electromagnet. If the electromagnet properly actuates, check input terminal connections on the case or multiplier box terminal board. Refer to Table C2 for coil resistances.

d. If any measured values differ from those shown on one of the circuit schematics or on the Data Sheet, locate and replace the faulty component. If adequate repair facilities are not available, contact the nearest Esterline Angus field representative for instructions.

3.6 REPLACEMENT PARTS

All recording system parts are made available directly from Esterline Angus. When ordering a part, always give the description, part number and instrument serial number. Refer to PART A for a case-parts list and to the illustrations in this manual for other parts identification.

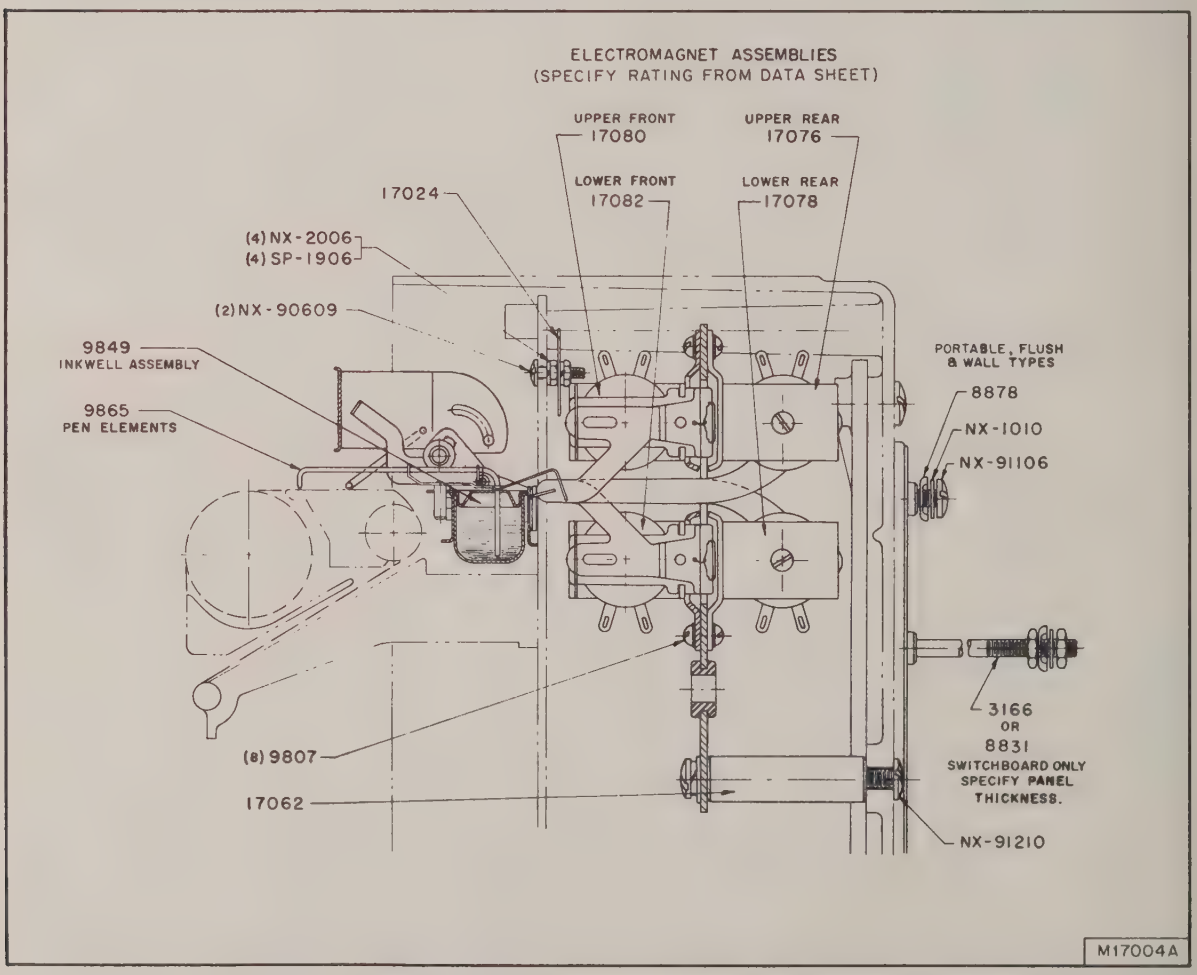


Figure C10A. Ink Writer (Model A620X) Recording System Parts Location.

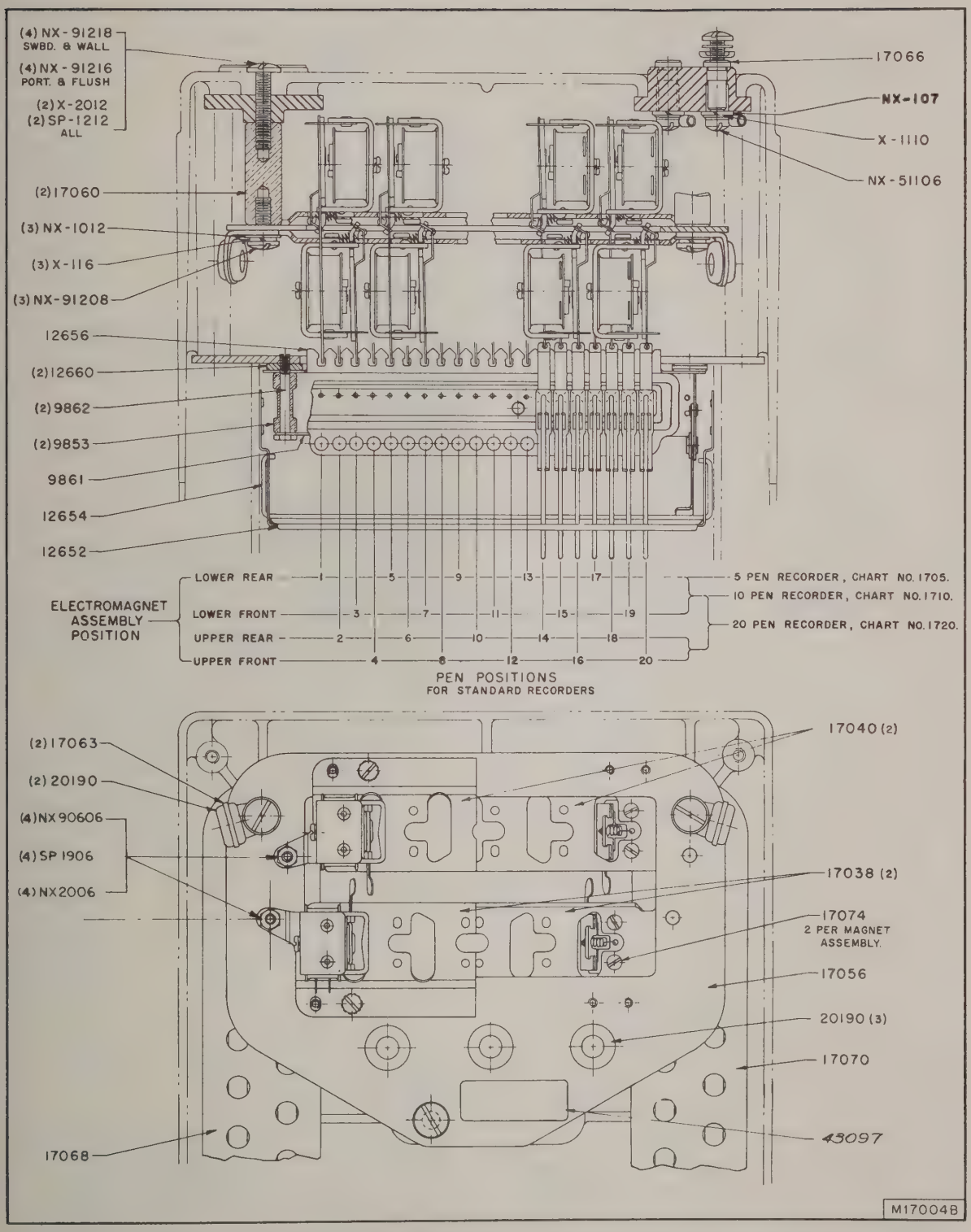


Figure C10B. Ink Writer (Model A620X) Recording System Parts Location.

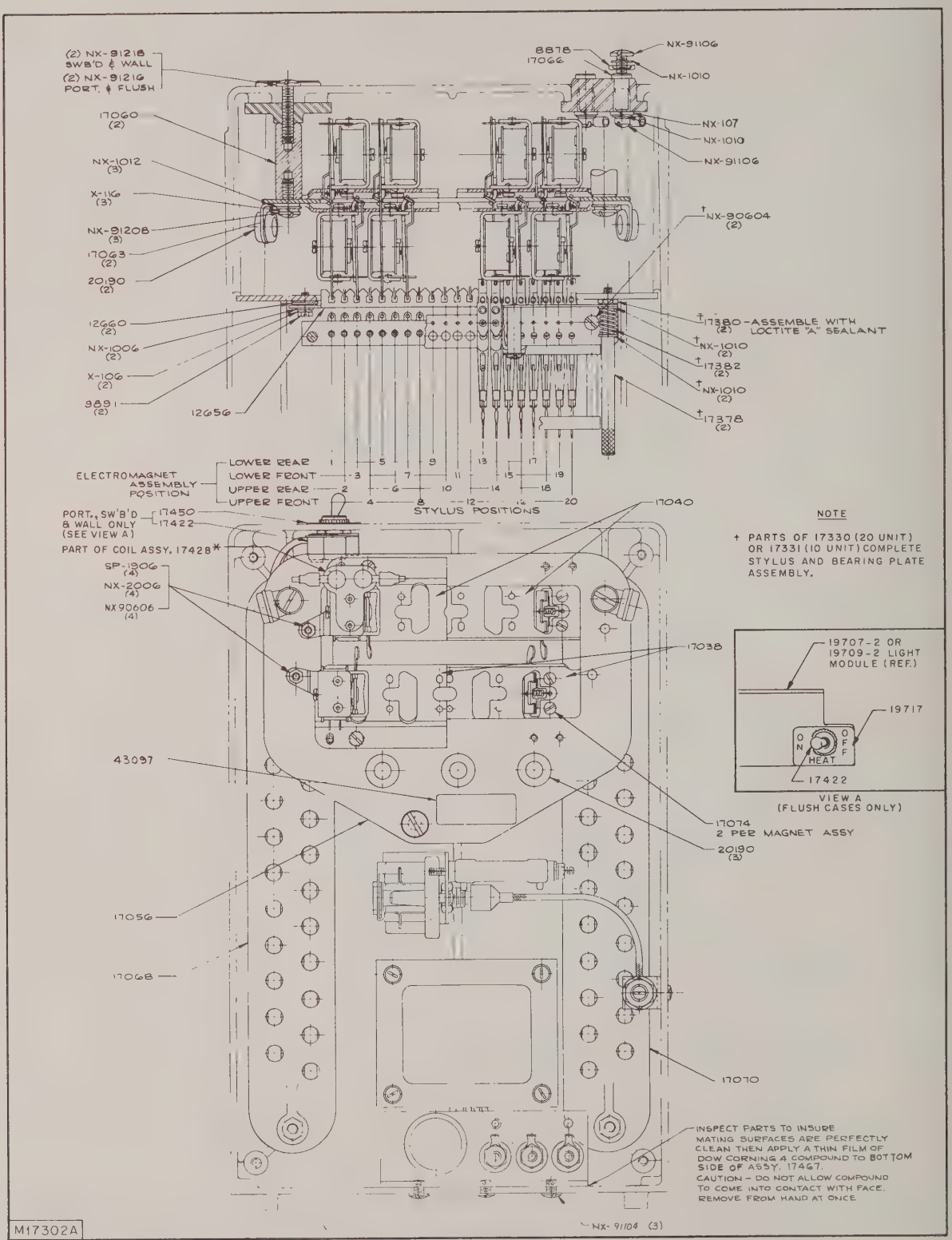


Figure C11A. Heat Writer (Model A620T) Recording System Parts Location.

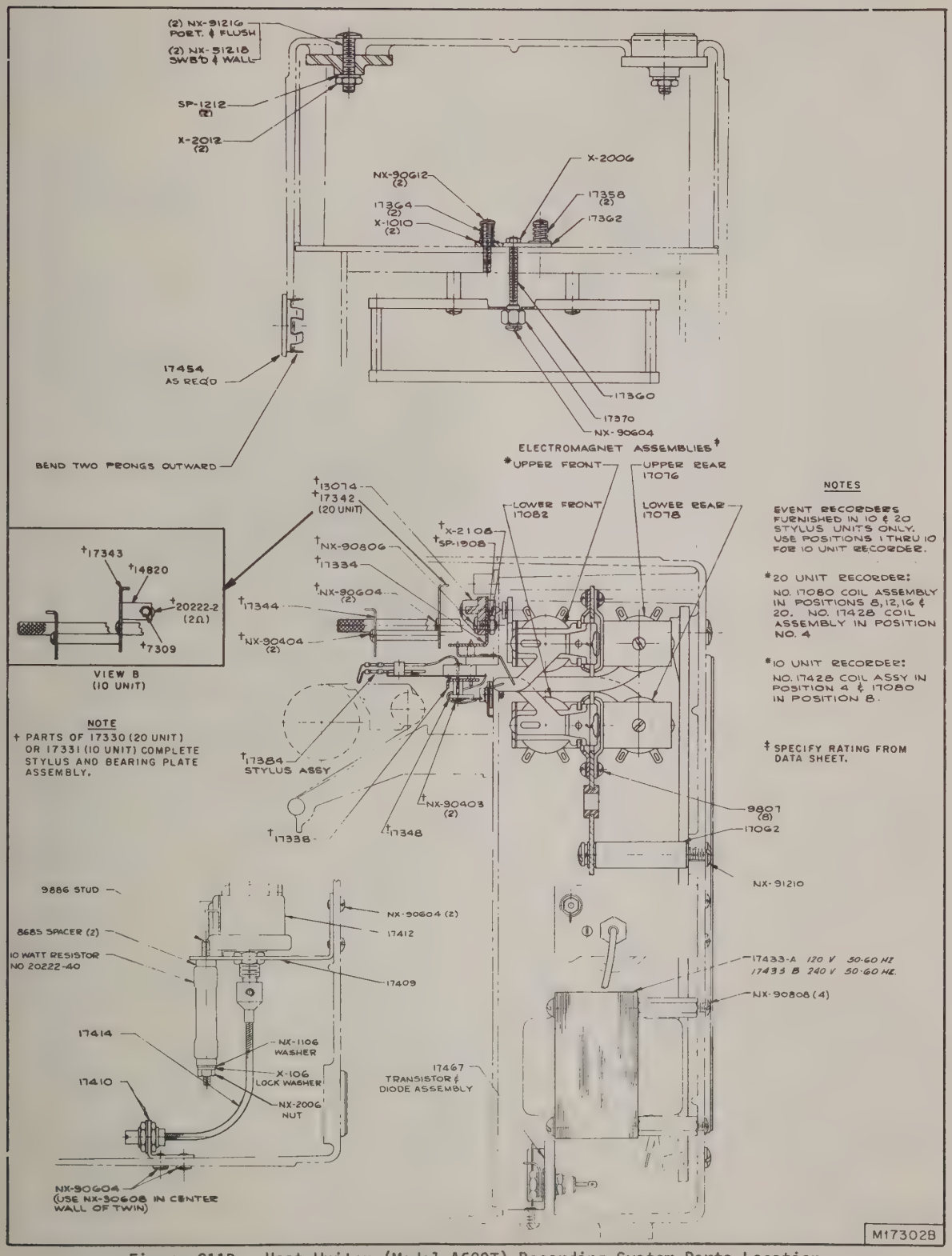


Figure C11B. Heat Writer (Model A620T) Recording System Parts Location.

TABLE C3
INK-WRITER RECORDER (MODEL A620X) TROUBLESHOOTING GUIDE

TROUBLE SYMPTOM	PROBABLE CAUSE	SUGGESTED REMEDY
System inoperative (no deflection).	Source failure or faulty connection.	Check input signal and all connections (refer to para. 2.2.2).
	Open or defective event recording circuit.	Test and replace faulty component(s) (refer to para. 3.5).
All pens displaced too far to right or left.	Pen actuating levers not properly aligned.	Adjust comb bar (refer to para. 2.5.1c).
Only some pens displaced too far to right or left.	Bent pen tips.	Carefully bend each displaced pen until proper tracking is achieved (refer to para. 2.5.1f).
Buzzing electromagnet.	Foreign object obstructing armature.	Remove foreign object so arm moves freely.
All pens fail to record.	Dirty pen points or contaminated ink.	Clean inking system (refer to para. 3.2.3).
An individual pen fails to deflect.	Foreign material at pen pivot.	Clean pivot.
	Defective electromagnet circuit, or loss of event signal.	Replace electromagnet assembly (see Figure C10) or repair possible defective wiring.
	Pen element tails not properly engaging electromagnet arm.	Check and correct pen element installation (refer to para. 3.3).
Inking system inoperative.	Loss of prime or clogged pens.	Reprime or clean system (refer to para. 3.2.3).
Ink pen skips.	Incorrect pen balance.	Increase pen pressure (refer to para. 2.5.1a & b).
	Restricted ink flow.	Clean pen (refer to para. 3.2.3).
	Pen element improperly installed.	Check pen element installation (refer to para. 3.3).
Ink trace spreads on chart paper.	Inferior ink or chart.	Use only recommended EA supplies.
	Dirty pen points or contaminated ink.	Clean inking system (refer to para. 3.2.3).

TABLE C4

HEAT-WRITER RECORDER (MODEL A620T) TROUBLESHOOTING GUIDE

TROUBLE SYMPTOM	PROBABLE CAUSE	SUGGESTED REMEDY
System inoperative (no deflection).	Source failure or faulty connection.	Check input signal and all connections (refer to para. 2.2.2)
	Open or defective event recording circuit.	Test and replace faulty component(s) (refer to para. 3.5).
Recorded lines on chart too light.	Stylus temperature too low.	Advance stylus-heat control (refer to para. 2.5.2a & b)
	Stylus pressure too great.	Adjust stylus pressure (refer to para. 2.5.2 c-g).
	Chart speed changed from hour to minute feed.	Adjust stylus pressure (refer to para. 2.5.2 c-f) or increase stylus heat (para. 2.5.2a & b).
Recorded lines on chart too heavy	Stylus temperature too high.	Reduce stylus heat (refer to para. 2.5.2a & b).
	Stylus pressure too light.	Adjust stylus pressure (refer to para. 2.5.2 c-g).
	Chart speed changed from minute to hour feed.	Adjust stylus pressure (refer to para. 2.5.2 c-g) or decrease stylus heat (para. 2.5.2a & b).
Stylus tips drag and do not record lateral movements.	Stylus pressure too great.	Adjust stylus pressure (refer to para. 2.5.2 c-g).
Recorded lines are wide and blurry.	Stylus pressure too light.	Adjust stylus pressure (refer to para. 2.5.2 c-g).
All styluses displaced too far to right or left.	Stylus actuating levers not properly aligned.	Adjust comb bar (refer to para. 2.5.2 h & i).
Only some styluees displaced too far to right or left	Bent stylus tips.	Turn off stylus heat, allow tips to cool, and carefully bend each displaced stylus.
Buzzing electromagnet.	Foreign object obstructing armature.	Remove foreign object so arm moves freely.
All styluses fail to record.	Poor connection at connection head.	Repair connection.
	Defective stylus-heat circuit.	Repair power supply (see Fig. C11 & Fig. C12).
An individual stylus fails to deflect.	Foreign material at stylus pivot.	Clean pivot.
	Defective electromagnet circuit, or loss of event signal.	Replace electromagnet assembly (see Fig. C11) or repair possible defective wiring.
Stylus tip burns; then opens.	Stylus shorted to metal roller and protective circuit inoperative.	Check zener diode CR3 in protective circuit of stylus heat power supply (see Fig. C11 & Fig. C12).
Leading edge of holes in chart paper tear.	Stylus pressure too great.	Adjust stylus pressure (refer to para. 2.5.2 c-g).
	Chart paper binding.	See that supply arbor turns freely.

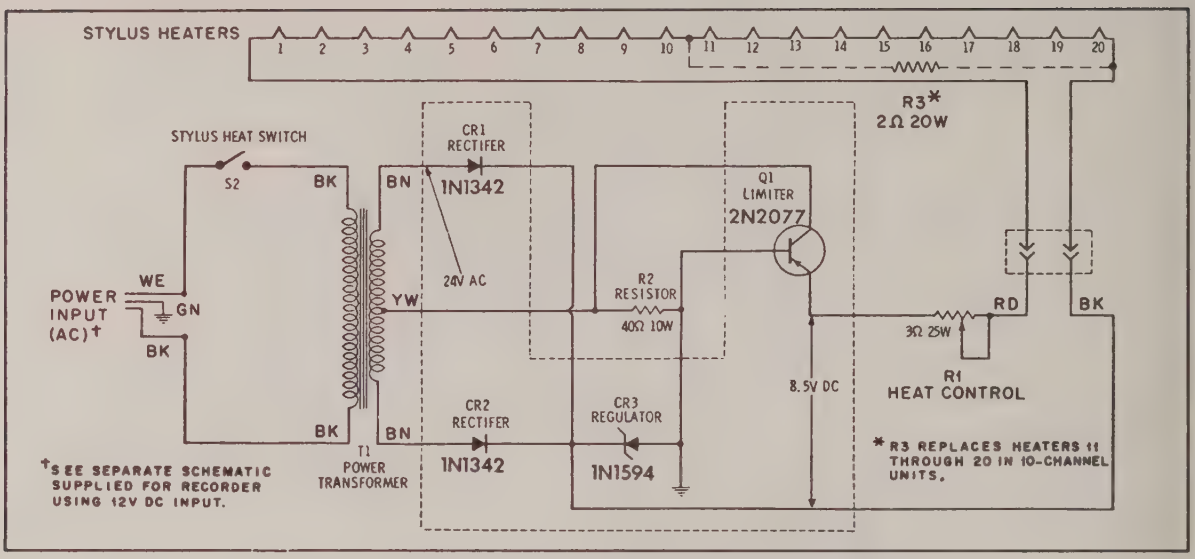


Figure C12. Model A620T Stylus-Heat Circuit Schematic.

PART D

APPENDIX

SECTION 1 - GENERAL

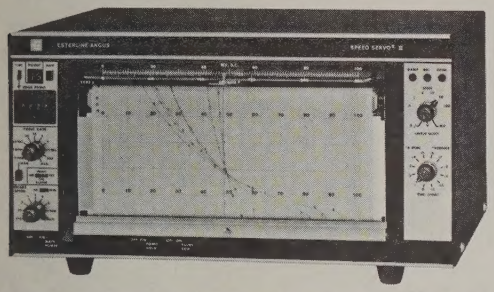
1.1 This part of the manual contains supplemental information covering special modifications and optional equipment for Esterline Angus Event Recorders. When applicable, the APPENDIX will also include production change notices which will describe the latest design improvements in the recorder. Any necessary corrections to the rest of the manual will be included with these production change notices.

1.2 The Data Sheet accompanying this manual is a customized specification form that accurately describes the instrument supplied. Electrical power and signal input ratings are reflected on the Data Sheet as well as part numbers and information concerning optional attachments, accessories, and special parts and drawing numbers.

1.3 The Serial Number on the Data Sheet must be included in any correspondence concerning your recorder. All orders for replacement parts, supplies, and optional equipment must include the Serial Number to allow Esterline Angus to furnish parts and supplies that are compatible with your specific instrument.

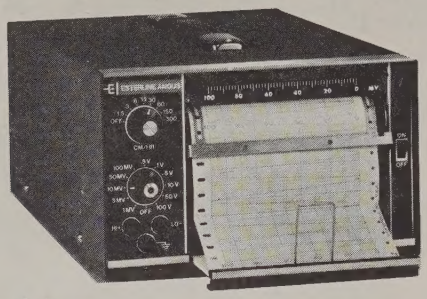
NOTE: Do not misplace the Data Sheet; always keep it with the instrument or with this manual.

Record up to 24 points without ink!



New Speed Servo® II thermal matrix multipoint recorder brands a clean analog record of 4, 6, 8, 12 or 24 data channels on 10″ calibrated chart. Can print time or ID number along with data. Saves on paper over ink models because it prints such a clear record you can run chart slower with each channel identified. Features one moving part linear servo motor, conductive plastic feedback potentiometer, 1 sec/point print rate, accuracies to ±0.25% of span. Accepts thermocouple, millivolt, and volt inputs. Four types of chart drives, fixed or variable speeds. Request Bulletin F 720.

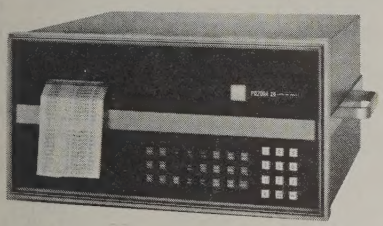
Battery Miniservo® recorder



72-hour delivery

For field or remote applications. Input spans are 1, 5, 10, 50, 100, and 500 mVDC and 1, 5, 10, 50, and 100 VDC, with ±100% zero adjust. Eight chart speeds from 1.5 to 300 cm/hr. 10 cm wide, Z-fold chart. The rugged Miniservo recorder is powered by internal 12V 8-hour rechargeable battery, or from external battery, or plugged into line power. Replaceable throwaway pen/ink cartridge. For fast delivery, order stock number S22243.

SMART new data system learns from your finger to do YOUR job



1. Measure up to 248 low level signals accurately, immune from noise—*analog, digital, non linear.* Print them out, tape them, feed your computer (alarms too!).
2. Key program—with one finger—all clock timing, scan intervals, channel gains, I/O, engineering units, powerful subroutines like automatic programming and optional integration. Everything to do your job.

In the new PD-2064, a proven microprocessor, RAMs, and ROMs replace a bushel of expensive circuitry to make a versatile, standardized data acquisition system you can use for general or specific jobs. The big benefit to you is more data *reduced* per dollar. Request Bulletin B110.

NEW X-Y recorder 2/3 fewer parts

Spartan X-Y recorders deliver big new benefits. A revolutionary mechanical design eliminates more than ½ of the moving parts to boost reliability and performance. Parts reduction = cost reduction = more value per dollar. Spartan X-Y is stripped for OEM or dedicated use, or fitted with multi-range and time base for lab use. Features: 30″/sec or faster slewing speed, lifetime conductive plastic pot, disposable fiber-tip pen/ink unit, vacuum holddown, back-lighted grid alignment, op amp solid state electronics, 11″ x 17″* (or A3). 5 ranges: 1 MV to 10V/in*. 6 time bases: 0.01 to 2.0 in/sec*. (* or equivalent metric.) Request Bulletin E510.

For more information, write
Esterline Angus Instrument Corporation,
P.O. Box 24000, Indianapolis, IN 46224.
Or Call 317/244-7611.

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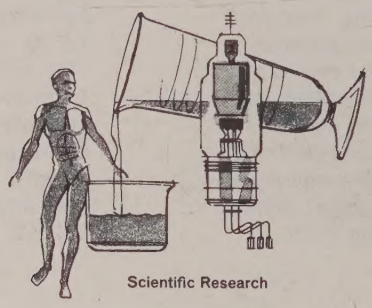
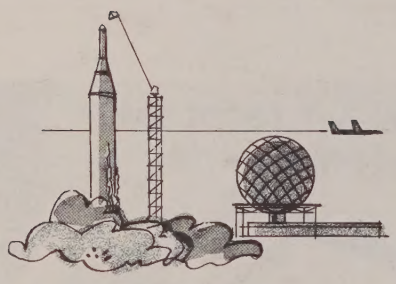
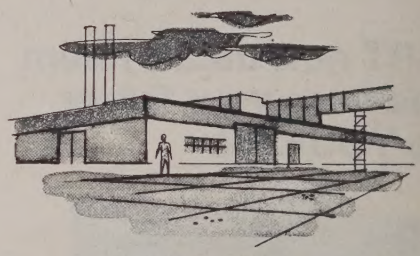


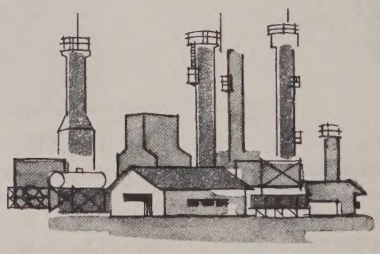
Scientific Research



Space Exploration



Production Analysis



Process Monitoring

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